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EDUCATION FOR ECONOMIC SECURITY ACT

HEARINGS

BEFORE THE

SUBCOMMITTEE ON EDUCATION, ARTS AND HUMANITIES

OF THE

COMMITTEE ON LABOR AND HUMAN RESOURCES UNITED STATES SENATE

NINETY-EIGHTH CONGRESS

FIRST SESSION

ON

S. 530

TO PROVIDE FOR A PROGRAM OF FINANCIAL ASSISTANCE TO STATES IN ORDER TO STRENGTHEN INSTRUCTION IN MATHEMATICS, SCIENCE, COMPUTER EDUCATION, FOREIGN LANGUAGES, AND VOCATIONAL EDUCATION, AND FOR OTHER PURPOSES

MARCH 8, 9, AND APRIL 8, 1983
WASHINGTON, D.C.
MARCH 21, 1983
WARWICK, R.I.

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CONTENTS

CHRONOLOGICAL LIST OF WITNESSES

TUESDAY, MARCH 8, 1983

WASHINGTON, D.C.

Page

Domenici, Hon. Pete V., a U.S. Senator from the State of New Mexico ... 7

Hart, Hon. Gary, a U.S. Senator from the State of Colorado ... 11

Rutherford, F. James, chief education officer, American Association for the Advancement of Science, Washington, D.C.; Bill G. Aldridge, executive director, National Science Teachers Association, Washington, D.C.; Stephen S. Willoughby, president, National Council of Teachers of Mathematics, Washington, D.C.; and David B. Leeson, president, California Microwave, Inc., Sunnyvale, Calif., and member, board of directors, American Electronics Association, a panel ... 15

Chiles, Hon. Lawton, a U.S. Senator from the State of Florida ... 16

Adler, Susan B., director, Washington office, Education Commission of the States, Washington, D.C.; Calvin M. Frazier, commissioner of education, State of Colorado, Denver, Colo., and president, Council of Chief State School Officers; Robert Wolfenbarger, vice president, New Jersey State Board of Education, Summit, N.J., and director, National Association of State Boards of Education; Robert L. Smith, executive director, Council for American Private Education, Washington, D.C.; and M. Joan Parent, first vice president, National School Boards Association, Washington, D.C., a panel ... 84

WEDNESDAY, MARCH 9, 1983

WASHINGTON, D.C.

Bell, Hon. Terrel H., Secretary of Education, accompanied by Carol Cichowski, Acting Director, Special Education, Rehabilitation and Research Analysis Division, Department of Education ... 273

McGuire, Willard, president, National Education Association; Albert Shanker, president, American Federation of Teachers; and Patricia Albjerg Graham, dean, graduate school of education, Harvard University, Cambridge, Mass., on behalf of the American Educational Research Association ... 290

Fretwell, E. K., Jr., chancellor, University of North Carolina at Charlotte, on behalf of the American Association of State Colleges and Universities; Howard D. Mehlinger, dean, school of education, and professor of education and history, Indiana University, Bloomington, Ind.; Rev. William J. Byron, president, Catholic University of America; Richard Brod, director, foreign language programs, Modern Language Association, and secretary-treasurer, Joint National Committee for Languages, Washington, D.C.; and Joshua Smith, president, Borough of Manhattan Community College, New York, N.Y., on behalf of the American Association of Community and Junior Colleges, and the Association of Community College Trustees ... 372

Johnson, Gilbert D., manager, education and training, Information Technology Group, Electronic Data Systems, accompanied by Milton Russell, general counsel, Association of Data Processing Service Organizations, and William Lucas, assistant superintendent, Los Angeles Unified School District ... 471

MONDAY, MARCH 21, 1983

WARWICK, R.I.

Page

Fogarty, Charles, on behalf of Hon. J. Joseph Garrahy, Governor, State of Rhode Island 550

Pontarelli, Arthur R., commissioner of elementary and secondary education, State of Rhode Island, accompanied by Charles Shea, chairman of the Rhode Island Board of Regents 552

McMahon, Eleanor M., commissioner of higher education, State of Rhode Island 564

Liston, Edward, president, Community College of Rhode Island; and William Flanagan, executive secretary, Rhode Island Independent Higher Education Association 571

McElroy, Edward, president, Rhode Island Federation of Teachers, and president, Rhode Island AFL-CIO; Herman Coleman, executive secretary, National Education Association, Rhode Island; Elizabeth Ann Kenyon, president, Rhode Island Association of School Committees, and member, South Kingston School Committee; Burton Froberg, executive secretary, Rhode Island Association of School Superintendents; Sister Marie Andre Buay, superintendent of diocesan schools; Donald Gainey, president, Rhode Island Association of School Principals, and principal, West Warwick High School; and Joanne Corbett, legislative chairperson, Rhode Island Congress of Parents and Teachers 577

Sweet, David, president, Rhode Island College; and Frank Newman, president, University of Rhode Island 607

THURSDAY, APRIL 8, 1983

WASHINGTON, D.C.

Warner, Hon. John W., a U.S. Senator from the State of Virginia 619

Tsongas, Hon. Paul E., a U.S. Senator from the State of Massachusetts 624

Roberts, Jessie S., science teacher, Welch Junior High School, Welch, W. Va.; Dr. Quincalee Brown, executive director, American Association of University Women, Washington, D.C.; Maida Townsend, president, Vermont National Education Association, Montpelier, Vt.; and Maudine Cooper, Urban League 672

Hamburg, Dr. David A., president, Carnegie Corp. of New York, New York, N.Y.: Dr. Roger Nichols, director, Museum of Science, Boston, Mass.; and Stephen Salyer, vice president and director, education division, WNET-TV, New York, N.Y., a panel 705

STATEMENTS

Adler, Susan B., director, Washington office, Education Commission of the States, Washington, D.C.; Calvin M. Frazier, commissioner of education, State of Colorado, Denver, Colo., and president, Council of Chief State School Officers; Robert Wolfenbarger, vice president, New Jersey State Board of Education, Summit, N.J., and director, National Association of State Boards of Education; Robert L. Smith, executive director, Council for American Private Education, Washington, D.C.; and M. Joan Parent, first vice president, National School Boards Association, Washington, D.C., a panel 84

  Prepared statement 87

American Educational Research Association, Patricia Albjerg Graham, on behalf of, prepared statement 354

American Electronics Association, David B. Leeson, on behalf of, prepared statement 70

Bell, Hon. Terrel H., Secretary of Education, accompanied by Carol Cichowski, Acting Director, Special Education, Rehabilitation and Research Analysis Division, Department of Education 273

  Prepared statement 276

Brod, Richard, director, Foreign Language Programs/Modern Language Association, prepared statement 432

Brown, Dr. Quincalee, executive director, American Association of University Women, prepared statement 686

Page

Byron, Rev. William J., S.J., president, Catholic University of America, prepared statement 444

Children's Television Workshop, Joan Ganz Cooney, president, prepared statement 769

Chiles, Hon. Lawton, a U.S. Senator from the State of Florida 16

  Prepared statement 20

Dodd, Hon. Christopher J., a U.S. Senator from the State of Connecticut, prepared statement 6

Domenici, Hon. Pete V., a U.S. Senator from the State of New Mexico 7

Fogarty, Charles, on behalf of Hon. J. Joseph Garrahy, Governor, State of Rhode Island 550

Frazier, Calvin, president, Council of Chief State School Officers, prepared statement 121

Fretwell, E. K., Jr., chancellor, University of North Carolina at Charlotte, on behalf of the American Association of State Colleges and Universities; Howard D. Mehlinger, dean, school of education, and professor of education and history, Indiana University, Bloomington, Ind.; Rev. William J. Byron, president, Catholic University of America; Richard Brod, director, foreign language programs, Modern Language Association, and secretary-treasurer, Joint National Committee for Languages, Washington, D.C.; and Joshua Smith, president, Borough of Manhattan Community College, New York, N.Y., on behalf of the American Association of Community and Junior Colleges, and the Association of Community College Trustees 372

  Prepared statement 375

Frobert, Burton, executive director, Rhode Island School Superintendents' Association, prepared statement 592

Gainey, Donald D., president, Rhode Island Association of School Principals, prepared statement 584

Great Lakes Colleges Association and Associated Colleges of the Midwest, Jon W. Fuller, president, prepared statement 543

Hamburg, Dr. David A., president, Carnegie Corp. of New York, New York, N.Y.; Dr. Roger Nichols, director, Museum of Science, Boston, Mass.; and Stephen Salyer, vice president and director, education division, WNET-TV, New York, N.Y., a panel 705

  Prepared statement 710

Handler, Dr. Harry, superintendent, Los Angeles Unified School District, prepared statement 483

Hart, Hon. Gary, a U.S. Senator from the State of Colorado 11

Huddleston, Hon. Walter D., a U.S. Senator from the State of Kentucky, prepared statement 669

Johnson, Gilbert D., manager, education and training, Information Technology Group, Electronic Data Systems, accompanied by Milton Russell, general counsel, Association of Data Processing Service Organizations, and William Lucas, assistant superintendent, Los Angeles Unified School District 471

  Prepared statement 473

Liston, Edward, president, Community College of Rhode Island; and William Flanagan, executive secretary, Rhode Island Independent Higher Education Association 571

McElroy, Edward, president, Rhode Island Federation of Teachers, and president, Rhode Island AFL-CIO; Herman Coleman, executive secretary, National Education Association, Rhode Island; Elizabeth Ann Kenyon, president, Rhode Island Association of School Committees, and member, South Kingston School Committee; Burton Froberg, executive secretary, Rhode Island Association of School Superintendents; Sister Marie Andre Buay, superintendent of diocesan schools; Donald Gainey, president, Rhode Island Association of School Principals, and principal, West Warwick High School; and Joanne Corbett, legislative chairperson, Rhode Island Congress of Parents and Teachers 577

McGuire, Willard, president, National Education Association; Albert Shanker, president, American Federation of Teachers; and Patricia Albjerg Graham, dean, graduate school of education, Harvard University, Cambridge, Mass., on behalf of the American Educational Research Association 290

  Prepared statement (with attachments) 294

McMahon, Eleanor M., commissioner of higher education, State of Rhode Island 564

  Prepared statement 566

Mehlinger, Dr. Howard D., dean, school of education, and professor of education and history, Indiana University, prepared statement (with attachment). 405

Page
National Association of Public Television Stations, Stephen Salyer, vice president and director, educational division, WNET/Thirteen, on behalf of, prepared statement 729
National Congress of Parents and Teachers, prepared statement 758
National Science Teachers Association, Robert E. Yager, president, and Bill G. Aldridge, executive director, joint prepared statement 39
Newman, Frank, president, University of Rhode Island, prepared statement 609
Nichols, Roger, director, Museum of Science, Boston, Mass., prepared statement 738
Parent, M. Joan, first vice president, National School Boards Association, prepared statement 160
PEER, Project on Equal Education Rights, prepared statement 773
Pontarelli, Arthur R., commissioner of elementary and secondary education, State of Rhode Island, accompanied by Charles Shea, chairman of the Rhode Island Board of Regents 552
  Prepared statement 555
Randolph, Hon. Jennings, a U.S. Senator from the State of West Virginia, prepared statement 4
Rhode Island Congress of Parents and Teachers, prepared statement 580
Roberts, Jessie S., science teacher, Welch Junior High School, Welch, W. Va.; Dr. Quincalee Brown, executive director, American Association of University Women, Washington, D.C.; Maida Townsend, president, Vermont National Education Association, Montpelier, Vt.; and Maudine Cooper, Urban League 672
Rutherford, F. James, chief education officer, American Association for the Advancement of Science, Washington, D.C.; Bill G. Aldridge, executive director, National Science Teachers Association, Washington, D.C.; Stephen S. Willoughby, president, National Council of Teachers of Mathematics, Washington, D.C.; and David B. Leeson, president, California Microwave, Inc., Sunnyvale, Calif.; and member, board of directors, American Electronics Association, a panel 15
  Prepared statement 29
Shanker, Albert, president, American Federation of Teachers, AFL-CIO, prepared statement 312
Smith, Joshua, president, Borough of Manhattan Community College, prepared statement (with attachment) 451
Smith, Robert L., executive director, Council for American Private Education, prepared statement 152
Stennis, Hon. John C., a U.S. Senator from the State of Mississippi, prepared statement (with attachments) 636
Sweet, David, president, Rhode Island College; and Frank Newman, president, University of Rhode Island 607
Townsend, Maida F., president, Vermont National Education Association, prepared statement 675
Tsongas, Hon. Paul E., a U.S. Senator from the State of Massachusetts 624
  Prepared statement 626
Warner, Hon. John W., a U.S. Senator from the State of Virginia 619
  Prepared statement 621
Willoughby, Stephen S., president, National Council of Teachers of Mathematics, prepared statement 61
Wolfenbarger, Robert, director, National Association of State Boards of Education, prepared statement 138

ADDITIONAL INFORMATION

Articles, publications, etc.:

  A Nickel-a-Book Tax? by William J. Byron, from the Washington Post, Thursday, February 3, 1983 448
  American Federation of Teachers Report on the Math/Science Teacher Shortage, Curriculum Standards, Business Involvement and Computer Activity 325
  Criteria for Assessing Math/Science Education Proposals 602
  Low-Tech Education Threatens the High-Tech Future, from Business Week, March 28, 1983 596
  National Assessment Findings and Educational Policy Questions, by Rexford Brown, from the Education Commission of the States, December 1982 94

Articles, publications, etc.—Continued

Page
Science, Museums and Science Education, by Bonnie VanDor, executive director, Association of Science-Technology Centers, February 10, 1983 .. 741

Communications to:

Garn, Hon. Jake, a U.S. Senator from the State of Utah, from Bill G. Aldridge, executive director, National Science Teachers Association, Washington, D.C., February 21, 1983 (with attachments) 220
Kennedy, Hon. Edward M., a U.S. Senator from the State of Massachusetts, from William L. Lucas, assistant superintendent, Los Angeles Unified School District, Los Angeles, Calif., March 22, 1983 528
McCurdy, Hon. Dave, a Representative in Congress from the State of Oklahoma, from Charles B. Saunders, Jr., vice president for governmental relations, American Council on Education, Washington, D.C., February 18, 1983 468
Stafford, Hon. Robert T., chairman, Subcommittee on Education, Arts and Humanities, from:
  Lucas, William L., assistant superintendent, Los Angeles Unified School District, Los Angeles, Calif., March 22, 1983 525
  Roukema, Hon. Marge, John N. Erlenborn, and William F. Goodling, Representatives in Congress, April 12, 1983 756

Questions and answers:

Responses of Bill G. Aldridge, executive director, National Science Teachers Association to questions asked by:
  Senator Stafford (with enclosures) 174
  Senator Pell (with enclosures) 214
Responses of Stephen S. Willoughby, president, National Council of Teachers of Mathematics to questions asked by:
  Senator Pell 229
  Senator Dodd 233
  Senator Stafford 234
Responses of Dr. David B. Leeson, president, California Microwave, Inc. to questions asked by Senator Stafford in letters dated:
  March 10, 1983 239
  March 25, 1983 242
Responses of Robert L. Smith, executive director, Council for American Private Education to questions asked by Senator Stafford 244
Responses of Gilbert D. Johnson, manager, training and education, Electronic Data Systems Corp. to questions asked by Senators Pell and Dodd 246
Responses of Robert Wolfenbarger, vice president, New Jersey State Board of Education to questions asked by Senator Stafford 248
Responses of Calvin M. Frazier, president, Council of Chief State School Officers, to questions asked by Senator Stafford 252
Responses of M. Joan Parent, first vice president, National School Boards Association to questions asked by Senator Stafford 255
Responses of Susan B. Adler, director, Washington office, Education Commission of the States to questions asked by Senator Stafford 259
Responses of Albert Shanker, president, American Federation of Teachers to questions asked by Senator Stafford 323
Responses of Willard McGuire, president, National Education Association to questions by Senator Stafford 495
Responses of Patricia Albjerg Graham, dean, Harvard University to questions asked by Senator Stafford 496
Responses of E. K. Fretwell Jr., chancellor, University of North Carolina at Charlotte, to questions asked by:
  Senator Stafford 501
  Senator Dodd and Pell 505
Responses of Howard Mehlinger dean, Indian University to questions asked by Senator Stafford 506
Responses of William J. Byron, S.J., president, Catholic University of America to questions asked by:
  Senator Stafford 509
  Senators Pell and Dodd 511
Responses of Richard I. Brod, director, Foreign Language Programs, MLA, to questions asked by Senator Stafford 513
Responses of Joshua L. Smith, president, Borough of Manhattan Community College to questions asked by Senator Stafford 515

Questions and answers—Continued
Page
Responses of Gilbert D. Johnson, manager, training and education, Electronic Data Systems Corp. to questions asked by Senator Stafford 517
Responses of William L. Lucas, assistant superintendent, Los Angeles Unified School District, to followup questions asked by Senator Stafford in letters dated:
March 25, 1983 530
April 13, 1983 534
April 14, 1983 540

EDUCATION FOR ECONOMIC SECURITY ACT

TUESDAY, MARCH 8, 1983

U.S. SENATE,
SUBCOMMITTEE ON EDUCATION, ARTS AND HUMANITIES,
OF THE COMMITTEE ON LABOR AND HUMAN RESOURCES,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10:03 a.m., in room SD-430, Dirksen Senate Office Building, Senator Robert T. Stafford (chairman of the subcommittee) presiding.

Present: Senators Stafford, Pell, and Quayle.

Also present: Senators Domenici, Hart, and Chiles.

OPENING STATEMENT OF SENATOR STAFFORD

Senator **STAFFORD**. The Subcommittee on Education, Arts and Humanities will come to order.

I am very pleased to convene this first day of hearings on legislative responses to the problems of mathematics, science, and foreign language education, problems which impede America's economic growth and undermine our national security.

Legislation to deal with the critical shortage of teachers qualified to instruct students in mathematics, science, and foreign languages is urgently needed in the United States if this country is to compete adequately with other nations in an increasingly competitive economic arena.

The litany of our deficiencies in these areas is appalling. Nationwide, according to my most recent information, 22 percent of teaching posts in mathematics are unfilled. In 1981, half the newly hired instructors in mathematics and science in secondary schools were not certified to teach those subjects.

Virtually five times as many science and mathematics teachers left the teaching profession for nonteaching jobs than left due to retirement. Fewer than one-half of the high school graduates have taken even 1 year of a foreign language as a part of their curriculum.

Certainly, education is principally a State and local responsibility, and our State and local school boards and our colleges and universities must play a major role in responding to these glaring deficiencies. So, too, must industry and our educational system fashion a cooperative approach to solving these problems.

Yet, there is also the national problem of our ability to cope generally with rapidly changing technology and changing labor-force requirements, and a pressing national need to improve our international economic competitiveness. These national problems demand a response at the Federal level.

Numerous bills to address these problems have been introduced in the House of Representatives on both sides of the aisle, and our colleagues in the House have moved quickly to pass legislation to deal with them.

I, too, believe that there is a most serious and urgent need for legislation, for any legislative response to improve teaching and learning in math, science, and foreign languages will have to have as its goal the development of a more technically competent and knowledgeable citizenry. This is indeed a long-range goal, but we must act deliberately and soon if it is to be achieved.

On February 17, Senator Pell and I introduced S. 530, the Education for Economic Security Act. I believe that this legislation represents a good start in the subcommittee's efforts to fashion a measured approach to a complex set of problems in mathematics, science, and foreign language education, problems which cut across our education system at all levels.

I recognize that our legislative approach falls within the jurisdiction of the Department of Education. Therefore, it should be seen as the foundation for a more comprehensive approach which includes a merit-based program under the aegis of the National Science Foundation.

I intend to work closely with the chairman and ranking member of the full Labor and Human Resources Committee, Senators Hatch and Kennedy, under whose jurisdiction the NSF falls, to develop such an initiative.

Through our hearings, we hope to accomplish three things: first, to determine the nature and magnitude of our problems of mathematics, science, and foreign language education; second, to assess current and prospective initiatives at all levels of government and within the private sector to address these problems; and third, to develop the most appropriate Federal legislative approach which will help us to strengthen America's economy and security.

I look forward to this challenge and to working closely, as always, with my subcommittee colleagues, and particularly our ranking member, Senator Pell, who I hope will be here later. A severe illness suddenly developed in his staff and that is why he is not here now. We will enter his statement into the record at this point.

[The following was received for the record:]

Opening Statement of Senator Pell

Senator Pell. At the outset, Mr. Chairman, I want to commend you for holding this, the first of several hearings on S. 530, the Education for Economic Security Act, and on related science and mathematics legislative proposals before this subcommittee.

These hearings could well be the most important education hearings we will hold this year. Their importance can be seen in the number of bills that have already been introduced in this area.

We are fortunate indeed this morning to hear from Senators Domenici, Hart, and Chiles. Each of these distinguished colleagues of mine has either introduced or will soon be introducing legislation in the math and science areas. I eagerly look forward to their testimony.

Tomorrow, we will hear from the Secretary of Education. I was very heartened when the President, in his state of the union address, called for a new Federal math and science initiative. I look forward to having the Secretary discuss that proposal as part of his testimony.

I am very hopeful that all of us—my colleagues and the administration—will be able to work together in coming up with a viable program. For this crisis we face in the area of mathematics, science, computer technology, and foreign language instruction is a crisis of the first order.

The crisis with which we are confronted is not at all unlike the Sputnik crisis of the late fifties. It involves acute teacher shortages, inadequacy of instruction, a lack of emphasis on important national priorities, insufficient materials and equipment, too little vocational training in new and emerging technologies, and a paucity of public funding.

I was in the Soviet Union when Sputnik was successfully launched and I witnessed the invigorating effect it had upon the Soviet people. I returned home to witness the truly remarkable response of our Nation. Almost immediately we identified our inadequacies and set a course to correct them.

It is equally critical today that we come to grips with the high technology demands placed upon our Nation. To my mind, that responsibility must be borne most heavily by our educational system. The adequacy of our response will in large measure depend upon the legislation that we fashion within this subcommittee. Let us take care, then, that we hear all voices and that we involve all parties in coming up with a Federal educational initiative that will enhance and strengthen the economic security of this great Nation.

Senator **Stafford**. Senator Randolph, who is today celebrating his 81st birthday, for which I am sure all of us wish him a most happy birthday and many happy returns today, has asked me to say in his behalf that he extends his apologies to the members of the subcommittee and today's witnesses for his necessary absence from these hearings.

Although he fully intended to be here and to join with others in expressing concern over the emergency nature of the need to improve the quality of math and science instruction in our Nation's schools, a meeting was called for the West Virginia delegation to find ways to avoid, if possible, the layoff of thousands of additional steelworkers in his State at a time when the State has the highest unemployment record in the Nation.

Senator Randolph wishes to reaffirm his commitment to the subcommittee—he does not need to do that as far as its chairman is concerned, because we know it—and to the educational community—and I think the educational community knows of his commitment—in working to design legislative initiatives to address our national science and math problems.

The Senator also, as I said, is celebrating his birthday, and not only his 81st birthday, ladies and gentlemen, but the 50th anniversary of his first swearing in as a Member of the U.S. House of Representatives in 1933.

We will include a statement from Senator Randolph and a statement from Senator Dodd in the record at this point.

[The following was received for the record:]

PREPARED STATEMENT OF SENATOR RANDOLPH

Senator **RANDOLPH**. Mr. Chairman, I am impressed by the vast array of bills that have been introduced to date addressing the newly emerging science and math needs in the education community. These many bills are indicative of the genuine concern among us concerning math and science education, and also indicates that the Congress believes the decline in the quality of these disciplines to be a national priority if not a national emergency.

I am pleased to be a cosponsor of S. 530, the bill introduced by our able ranking minority member, Senator Claiborne Pell. I consider this bill to be the model, or centerpiece of whatever final form the science and math initiative in the Senate might take. With so many bills pending, addressing the need through proposals that include tax deductions for donation of computer equipment, teacher inservice programs, and program-improvement grants to local school districts, as well as loan forgiveness and scholarships proposed for college students who desire to become secondary school math and science teachers—I believe that unless there is a real national concensus that we can afford an omnibus-bill approach to this emergency need in the two fields—we are apt to end up with bits and pieces of many bills, and insufficient funds to really make an impact on the problem at the State and local levels.

There are dozens of problems inherent in any initiative—omnibus or otherwise—to really address the inadequacies—without taking into account the complex governance system for education that must be accommodated in any national effort to relieve math and science teacher shortages and to improve the quality of math and science instruction in our schools. That complex governance system is comprised of 50 State systems and nearly 16,000 individual, or local, school districts nationwide.

Are we really sure how diverse the problem is? Doesn't it all depend on the various perspectives represented in the contentions about the "real" and "alleged" deficiencies in math and science education? Is the real problem a general condition associated with larger societal values and changing circumstances, or is it the result of one or more particular concerns?

We are responding now to the same problem we responded to when Russia hurled its first Sputnik into space. We responded by enacting the National Defense Education Act to remedy the allegation that we had a national shortage of qualified teachers in higher education and secondary schools, we had the need to replace outmoded equipment in schools and colleges, and to provide inservice training and curriculum development programs to improve the quality of instruction. The NDEA provided loans to students preparing to enter careers in areas of scarcity, grants for purchase of equipment, supervisory and consultancy services for teachers, fellowships for persons preparing to become college teachers, foreign language development—and many other authorities—none of which are currently funded to a great extent except for a few continued under other legislative provisions. For example, the student loans and grants under the Higher Education Act that was enacted in 1965, staff development and program improvement activities under the Elementary and Secondary Education Act, now known as chapter 2 of ECIA, and international education programs for foreign language instruction, also under the Higher Education Act—which by the way the President has zero-funded in his fiscal year 1984 budget request, and finally there are some programs still authorized under the Vocational Education Act.

Our task is formidable, Mr. Chairman. The magnitude of the problem appears to be great indeed. I doubt if we have the capability to provide a valid picture of need with the data we are able to obtain through spot surveys conducted by 50 State systems and 16,000 local school districts—all separate and disparate—to pinpoint just where the shortages, and perhaps surpluses of teachers already trained to teach math and science are—so how can we do a really good job of enacting legislation to remedy the problem without a comprehensive analysis of the extent to which the problem exists. Is it, as some groups claim, not really a shortage of such teachers nationwide, but merely a geographic maldistribution of those already adequately trained?

If there are areas in the country that have a surplus of such teachers, what incentive can we give them to leave home and teach in another State where a shortage exists? Most teachers refuse to leave their home States because most teacher retirement programs are not portable—and if that isn't enough to thwart an effort to redistribute these trained, qualified teachers, consider the fact of significant differences between teacher salaries among the 50 States, and the refusal of trained teachers to move around because of probable reduced income at other locations. And we know from experience that efforts to allow the Federal Government to address and resolve the teacher retirement problem would likely continue to be considered an "imposition of Federal intrusion" at the State level, encountering fierce resistance—as much so as any Federal initiative to address teacher certification requirements.

All we really know is there is a growing consensus that we appear to have unqualified precollege teachers, a shortage of teachers at the college and precollege level, too few math and science students in college, insufficient math and science courses or requirements in high school, inadequate exposure to math and science for students not planning to pursue a career in these disciplines, and the cumulative impact of a decade or more diving which educational priorities have emphasized equity and access while, according to some people, we sacrificed excellence in education. Which is true? All of the above, or none of the above?

When we enacted the National Defense Education Act, it reflected a broad categorical approach, with 11 separate titles, and it was considered a major breakthrough by proponents of Federal aid to elementary and secondary schools as well as higher learning institutions. But its supporters never forgot that a national emergency provided the rationale for its enactment. And with all that it provided, the NDEA was still criticized by some as having failed to reach those sectors of education in greatest need of help—such as schools in central city slums and depressed, isolated, rural areas.

Our approach to addressing what we perceive to be a real national need—a national priority to remedy inadequacies in science and math wherever they exist—must be carefully crafted so that we are not criticized by one interest group as trying to do too much with too little, or doing too little too late.

As members of this subcommittee, we will be asked by some interest groups to enact an omnibus bill; others will ask for targeting of our efforts. Some will insist on upgrading the competencies of current teachers rather than train new ones. Some will insist that out inadequacies in math and science is a result of insufficient offerings in schools and colleges, while others will say that we need only to make the content more relevant to current conditions. Shall we replace obsolet equipment, or consider alternate delivery systems such as joint programs among schools and cooperative programs between schools and industry?

With seven major initiatives addressing our math and science needs already introduced in the Senate (and six major initiatives in the House), and with at least two more major math and science initiatives expected to be introduced shortly, we are going to have numerous options to choose from—some of which will be politically acceptable and others that will be considered politically limited, purely from the standpoint of budgetary requirements alone.

We are, in short, going to be asked to limit the funding for our math and science initiative or initiatives, and if we limit our effort too severely we are going to end up passing legislation that represents no more that a token effort, neither "macro" nor "micro."

There are other approaches to resolving our math and science problems that are under discussion, but yet to be introduced.

As I stated earlier, there are many options open to us as Members in addressing the inadequacies of math and science teachers as well as the content of instructional programs in our schools. And our task of sorting out and selecting those options is formidable.

We need to proceed carefully and deliberately, and to begin modestly by enacting a bill, such as S. 530, and using it as the basic foundation for building upon in the future as we learn and understand more about this multifaceted problem.

PREPARED STATEMENT OF SENATOR DODD

Senator DODD. Mr. Chairman, I welcome the opportunity, as a member of this subcommittee, to participate in these proceedings. I commend you for the excellent job you have done in chairing these important hearings on the Education for Economic Security Act.

By now most everyone has read the statistics and reports proclaiming a national crisis in quality science and mathematics education. And I am certain that each of you is aware that the present generation of Americans has been dubbed as being scientifically and technically illiterate.

This comes at a time when the need for science and mathematics skills are becoming increasingly more important throughout the world. A prime example of the need for adequate science and mathematics knowledge and skills is emphasized by the new technology revolution.

At the same time that many reports proclaim that America's economic future will depend upon the success of high technology industries, other reports project a shortage of adequately trained people to fill the positions created by the new technology revolution. These predicted shortages are truly sadly ironic when 12 million Americans are looking for work.

Without increased knowledge and skills in science and mathematics, a significant number of positions in high technology industries will remain vacant and a lot of good people who are seeking jobs will continue to be unemployed and underemployed.

I do not pretend to know all the right questions, answers, or solutions to the Nation's science and mathematics dilemma. In my judgment, however, there are a number of issues which must be addressed. Among these are: teacher competency, adequate equipment and instrumentation for faculty and students, and new science and mathematics curriculum development.

These issues have been addressed in a bill which I am proud to have cosponsored, S. 530, the Education for Economic Security Act, introduced by Senators Pell, Stafford, and Cranston. This comprehensive legislation provides financial assistance to State and local education agencies to increase student knowledge and skills in science, mathematics, and foreign languages, and to foster better employment-based vocational education.

In addition, the concerns of a bill I introduced to provide qualified science and mathematics teachers in secondary schools are addressed in the Pell, Stafford, and Cranston legislation.

My bill, S. 401, the National Science and Mathematics Teachers Development Act, provides for workshops and other continuing education programs for secondary school science and mathematics teachers. These programs would be federally financed by grants to institutions of higher education to help upgrade the competency, substantive knowledge, communication skills, and teaching strategies.

The combined provisions of S. 401 and S. 530, in my opinion, are a practical and balanced attempt to solve the Nation's educational problems. These bills provide the means to insure that every student has access to the comprehensive knowledge and skills required by the high-technology revolution.

Senator STAFFORD. The Chair is exceedingly happy to recognize a very distinguished and able Member of the Senate who is also chairman of the Budget Committee and, I am very happy to say, a member of the other committee that I have the privilege of chairing, the Environment and Public Works Committee.

I know, Senator Domenici, that your interest in education is profound, and I am honored, as is the subcommittee, that you have found the time in your schedule to be here with us this morning and I welcome your testimony.

STATEMENT OF HON. PETE V. DOMENICI, A U.S. SENATOR FROM THE STATE OF NEW MEXICO

Senator DOMENICI. Thank you very much, Mr. Chairman. It is my privilege to be here.

I do not know if you know, Mr. Chairman, that I am a math teacher dropout. My first job in life was teaching math.

Senator **Stafford**. I should have met you about 50 years ago. [Laughter.]

Senator **Domenici**. That was a long time ago when I started, but I did not leave because I did not love it. I was challenged by somebody to go to law school, and I did.

From what I can tell, the problems I saw then in math and science have continued with one interruption for 8 or 10 years post-Sputnik, when the United States decided to get with it and place a special emphasis on math, science, and engineering education.

I was rather amazed, in seeking information from experts nationally and in my State, to have them stress how that post-Sputnik program had worked, but we had not found the ability to continue it in our school systems.

I have a prepared statement, Mr. Chairman. The first two or three pages of it are redundant to your excellent statement of the problem, so I will not read them. I will merely tell you that I was in the city of Los Alamos about 10 days before I introduced the bill that I will talk about here today, and I was still wondering whether the National Government ought to be involved in this area.

I ran into one of my best friends in the scientific community, and after all the heady budget talk and macroeconomic talk, he cornered me and said, "You know, all that sounds very good and it is all very important, but I hope you understand that if the United States does not get its act together with reference to math, science, engineering, and physics, and instill in our young people a desire to pursue those fields, and, in particular, find some way to stimulate good people to be math and science teachers, an awful lot of what you are talking about in terms of the American economy is not going to come into fruition, because our competitors in the world will beat us—in particular, Japan and Germany and a few others. He suggested quite firmly that we had better get with it.

Hearing that, along with 50 or 60 other experts in my State describing the serious nature of the problem, I concluded, No. 1, Mr. Chairman, that you are right on track in pursuing this effort with the introduction of your bill and holding these hearings today.

I know that the legislation which is going to eventually emerge from your committee will borrow good ideas from several science and math bills which have already been introduced. I want to just suggest that any Federal legislation should do at least the following:

It should encourage existing science and math teachers to stay in education rather than leaving for other positions. S. 248, the bill that I introduced with some cosponsors, addresses this issue through a teacher award program administered by the National Science Foundation.

Second, I think we must create incentives for more individuals to become science and math teachers. We propose a merit scholarship program for students studying to become math and science teachers. I believe this is unique among the Senate bills in this way. The House bill also contains a provision in this regard.

Third, we should allow States and local agencies great flexibility in the use of the money. Each State and each school district has unique problems. S. 248 deliberately builds on a chapter 2 block grant to promote flexibility and ease of administration.

Fourth, I think whatever bill you produce must bring the science and research communities and the education community and the private sector together to work on improving math and science education. There are many exciting things in existence by way of new technology and innovation that obviously are not being used. Somehow or another, we have to find some way to get those kinds of things into the school systems.

We attempt to do that by funneling the Federal effort through both the National Science Foundation and the Department of Education and by encouraging States to establish commissions or advisory councils with members from the scientific community, education, and private industry. While their name is the Commission on Excellence, it does not matter what they are called; we hope they serve the purpose of setting goals for the sovereign States in terms of excellence in these particular disciplines.

Fifth, we have to concentrate resources on those areas of greatest need. I know this is controversial, but no matter how much we would like it, billions of dollars simply are not available for this effort. More could be done to improve the quality of higher education, foreign language instruction, and certainly vocational education.

But perhaps it would be best to address these issues in separate legislation. For the present, in this vehicle it would be best to concentrate on directing resources into improving the quality of science and math in our elementary and secondary schools.

I introduced S. 248 with these goals in mind. There are undoubtedly many other approaches and good ideas that would be effective. I hope that the committee will carefully consider the provisions in S. 248, particularly the merit scholarship program. It might very well be from what I have learned that the merit scholarship program in S. 248 has to be strengthened and we might have to spend considerably more money in that regard.

S. 248 has been introduced, and I have had many conversations with parents, principals, teachers, and administrators on how the bill could be strengthened. With the permission of the chairman, I will submit a list of suggestions for the record that I determined in these talks and conversations.

Many of my colleagues have asked how I, as Budget Committee chairman, could propose funding a new Federal program, and I will just answer the question briefly. It is my opinion that we are moving not only into an economic recovery period, but certainly we are moving into some kind of transition with reference to our basic industry, our economic strengths, and how we are going to employ our people.

I do not think we know how all that is going to come out, but I think we do know that crucial to that transition and to the building blocks for this recovery is that we maintain preeminence in the development of high technology and leadership in science, research, math, and physics.

This type of legislation will help sustain a long-term recovery, and I think you have already expressed that clearly and I will not repeat it. No Senator is worried more about the effect of large deficits than I am, but I must say that there are things we must do in spite of that that have long-term recovery in mind and whose ultimate goal is prosperity and recovery. In this instance, I think we have to spend some money to make sure that that happens.

I want to close by just telling you, Mr. Chairman, that a couple of days ago I had a young boy in my office from a small rural school. He was up here as a Westinghouse science finalist, one of the 40 in the Nation, and I said, "Sit down for a while and let us talk."

He is a senior in high school. I tried to find out what enthused him hecause all he could talk about was physics and research and wanting to go to MIT or Cal Tech. I found that the two things that kept him involved in science studies the first sounds very simple, but the science fairs that we have in the United States and that involve the rural schools first stimulated him. He has been a winner in that for 7 consecutive years.

Then he was quick to add that his teachers were interesting, stimulating and worked hard. Even though he was in a little rural school, he had taken every math and science course around, and I was astounded to find that they had one course beyond trigonometry in that school. They had 2 years of physics; they had 2 years of chemistry and 2 years of biology.

So, I do not think we ought to be critical. Teachers and students are really trying out there, but the basic facts are startling in terms of deficiencies, in terms of teachers leaving, and in terms of turning off young students at 10, 11, or 12 years of age who do not want to have anything to do with math or science.

So, Mr. Chairman, the challenge is serious and significant, and I am very hopeful that with your commitment and dedication, you will put together the best of all the ideas.

I would say, Mr. Chairman, that there is a long-standing and difficult problem of whether you use the National Science Foundation as it was used in the post-Sputnik scientific and math effort, or whether you go the route of the Department of Education.

I am hopeful you will find some reasonable compromise, but I do believe the National Science Foundation has to be intimately involved. Thank you very much, Mr. Chairman.

Senator STAFFORD. Thank you very much, Senator. The subcommittee certainly appreciates your appearance; I do, especially, as Chairman. I can assure you that in considering this problem, we are going to borrow from all of the good ideas that come across from the witnesses, and I can see that some excellent ones are in your proposal. They will be seriously considered.

You mentioned the Sputnik era, which reminded me of a story from that time. I was then in Vermont State government, and I remember one of the jokes that circulated at that time was about a teacher who asked her class in the sixth grade to count from 1 to 10.

One little girl, whose father worked for our space effort at the time—we had not then gotten anything in the air to rival Sputnik—said she could do it. So, the teacher said, "Go ahead," and she said, "ten, nine, eight, seven, six, five, four, three, two, one, oh hell." [Laughter.]

Senator STAFFORD. Thank you very much, Senator.

Senator DOMENICI. Thank you.

Senator STAFFORD. You have to be fairly on in years to remember that. [Laughter.]

Senator STAFFORD. Senator Hart, we are delighted you have time to be with us this morning and we would be very glad to hear your testimony at this time.

This is another instance, I would say, ladies and gentlemen, where the Chair of this subcommittee is going to pay particular attention to the witnesses because Senator Hart also shares membership on the Environment and Public Works Committee, where we have labored together for a number of years.

Senator Hart, we are very happy you are here this morning.

STATEMENT OF HON. GARY HART, A U.S. SENATOR FROM THE STATE OF COLORADO

Senator HART. Mr. Chairman, thank you very much for your hospitality and, most of all, for holding these hearings.

For those of us who have been concerned with and, to a degree, identified with the broad range of education issues over the years and who particularly resisted for the last couple of years talk of abolishing the Department of Education and cutting funds for education, we are extremely pleased to see the number of Members of Congress now who have reawakened to the broad range of education issues and are beginning themselves not only to support measures put forward by some of us, but to introduce many of their own. I think the committee is very timely taking up that broad range of new initiatives.

We are all encouraged by this first series of hearings. We have all seen statistics indicating our children are falling behind in their learning of subjects having to do particularly with math and science and foreign language.

The Chairman and Senator Pell particularly over the years have demonstrated a concern about these areas and provided leadership therein.

We are all aware of the corresponding shortage of teachers, particularly, in these areas. Yet, we do not know the full scope of the situation, and I think these hearings will provide the base of data necessary to act.

As you know, the House recently passed a short-term, low-cost bill. Perhaps it is appropriate at this time, given increasing concern about the depth of the education problem, but I think we have to go much beyond this to some comprehensive, long-term approach. It is in that context that I am here this morning to support a measure which I reintroduced in February called the American Defense Education Act of 1983, which is essentially the same bill introduced about a year ago in the last session of Congress.

There was not any action on that bill, unfortunately, in the 97th Congress, but 12 of our colleagues have now joined as cosponsors of the measure.

I think, Mr. Chairman, you would agree with me that education is probably the best investment our Government and our society can make in its future. It is a national priority that must be reestablished and promoted by the highest levels of our Government. It is, as President Kennedy said 20 years ago, both the foundation and the unifying force of our democratic life.

Responsibility for our children's education is a shared responsibility. It rests on families, on communities, and on governments, all levels of governments. The American Defense Education Act draws on all three to meet the challenge of educating our children at a time when our Nation's economic and technological and defense needs are greater than at almost any other period in history.

The bill, as its title suggests, is patterned after the one that the chairman and Senator Domenici were referring to, or at least the period of the post-Sputnik period, the National Defense Education Act of 1958.

Today, we live in a period in which our economy is being so rapidly transformed that we can barely keep up. The transformation is probably as dramatic as it was during the industrial revolution of the 19th century. It is an economy shifting from primary reliance on heavy industry and basic manufacturing to increasing concentration on advanced and new technologies, information, communication, and services.

The opportunity for jobs and for economic growth and prosperity in this new economy depend more heavily than ever on our minds and not on our might or our muscle. Today, we have to rely on brainpower more than horsepower. And, of course, education and training is the key to that brainpower.

Unfortunately, as a country, we are failing to make the investment in education that is needed. Just when the information revolution requires all Americans to increase their competence in science and mathematics and technical skills, and when economic interdependence obliges us to master other languages to compete effectively abroad, we are letting our technical schooling erode and our foreign language studies decline.

There are some sobering statistics, according to the National Science Foundation. Between 1960 and 1977, almost two decades, the proportion of public high school students, grades 9 through 12, enrolled in science and mathematics courses declined from 60 to 48 percent in the case of science.

There has been a steady decline in the science achievement scores of the U.S. 17-year-old population, as measured in three national assessments of science in 1969, 1973, and 1977. Mathematics scores of 17-year-olds in this country declined significantly in two assessments of mathematics in 1973 and 1978. The decline was especially severe in the areas of problem solving and the applications of mathematics.

The mathematics and verbal scholastic aptitude test scores of students have declined steadily over an 18-year period through 1980. What is more dangerous is the fact that our toughest international competitors are doing exactly the opposite. They are devoting far more attention to educating their children in these vital areas.

One-half of all high school students in the United States take no mathematics or science beyond the 10th grade. In contrast, the Japanese secondary schools require nearly all the college-bound students to take three natural science courses and four mathematics courses during their 3-year high school career.

The Soviet Union, considered at least by this administration to be our principal competitor and opponent, has instituted a general curriculum at the primary and secondary levels which, in terms of its heavy focus on science and technology, is the most advanced in the world.

In addition to 2 years of calculus, all students in the Soviet Union are required to complete 5 years of physics, 4 years of chemistry, 4 years of biology, and 5 years of algebra.

It is not just the major industrialized countries either; it is other nations around the world that are working hard to prepare their young citizens for the future. I would like to just highlight, if I may, one such instance that I am aware of.

Kien Pham is an intern in my office this year. He was educated in the public schools of South Vietnam before escaping by boat with three dozen members of his family in 1977, successfully, I am glad to report.

The education he received in mathematics, science, and foreign languages from the public school system of this small, war-torn nation was superior to the average education in America today.

Earlier, I quoted the National Science Foundation when I stated one-half of all high school students in the United States take no mathematics or science beyond the 10th grade. By comparison, in the 10th, 11th, and 12th grades, Kien took mathematics, natural science, physics, chemistry, French, and English. It is important to note that this was the standard curriculum for all students in his class in the public schools of his nation.

Six months after his arrival in this country, Kien took the American College Test for admission to the University of Colorado. He scored in the 95th percentile in mathematics and slightly below norm in English. Apparently, his education in Vietnam was more than adequate.

Not surprisingly, our national inattention to science and mathematics is matched by a dangerous decline in the number of qualified teachers in this area. Further statistics by the National Science Foundation show that in 1981, 43 States of 45 responding reported a shortage of mathematics teachers. In the same year, 50 percent of the teachers newly employed nationwide to teach secondary science and math are actually uncertified to teach those subjects.

These statistics are alarming and could be devastating for this country's future. The situation demands an immediate national response. The American Defense Education Act is one such response and is designed to meet the specific shortfall that I have documented here this morning.

The American Defense Education Act provides that local school districts develop and implement programs in elementary and secondary schools to improve instruction and student achievement in mathematics, science, foreign languages, communications skills, and technology.

During each fiscal year, school districts, working with the ADEA program will be entitled to a basic payment based on the average per pupil expenditure in the State, and for those which can show substantial evidence that the program meets the ADEA goals for the year, an additional payment is available.

The bill encourages institutions of higher education to coordinate efforts with local school districts for the training and retraining of teachers through workshops, summer institutes, and inservice training.

Lastly, Mr. Chairman, the American Defense Education Act authorizes funds through the National Institute of Education to support research and development into effective teaching and learning techniques in math, science, and these other vital subjects.

The American Defense Education Act establishes an incentive program which is necessary to give needed Federal impetus to enable our country to meet the demands placed on our educational system by the technological changes and revolutions we are experiencing in today's world.

It is vital to our national economic well-being and our national security that the Federal Government provide the incentive to local school districts to develop a program which will train our young people for tomorrow's world and will eventually reach the goal of establishing the first and best education system in the world.

Mr. Chairman, in closing, many of the measures, if not all of the measures, proposed to this subcommittee and in the Congress in the last few months are designed to address specific elements of the education shortfall, if not the education crisis.

The American Defense Education Act is designed fundamentally to lift all education boards across this country, and it is in that spirit that it is offered for your consideration, for consideration of the Congress, and I hope for enactment this year.

Thank you very much.

Senator **Stafford**. Thank you very much, Senator. As we told Senator Domenici, Senator Pell and I have a bill—Senator Domenici does, you do, and it will be our intention to review them all carefully, borrow any good ideas we see, and we will consider your proposal very carefully. We are very pleased that you found the time to join us in your very busy schedule.

Senator **Hart**. My pleasure. I want to again say that all Senators, and I think the country, are aware of the work that Senator Pell has done throughout his public career, as well as you, Mr. Chairman. You have not, either of you, flagged in your commitment to education even during a period when it was popular to do so.

Senator **Pell**. Thank you very much indeed. I concur in what the chairman said. We hope to weave together these different approaches and make a good bill out of it. I remember being in Moscow when Sputnik went up and the exhilaration that that gave to the Soviet people. The spur that it gave to us—we created the National Defense Education Act out of it—was very necessary, and we need another spur. Maybe these bills and the public sentiment at this time will be that spur.

Also, I remember handling the Hungarian refugee problems for the International Rescue Committee in Europe in 1956, and I noticed that those students, when they came to America to high school, although they could not speak the language, as soon as they got control of the language, they were usually 2 years ahead of our students, paralleling the very point that you made, Senator Hart.

Senator HART. Well, Mr. Chairman, I hope that we do not have to have another shock of the Sputnik sort to shock this Nation into acting.

Senator PELL. Maybe these various approaches will do the trick. I hope so.

[Whereupon, Senator Pell assumed the Chair.]

Senator HART. I hope so.

Senator PELL. Thank you very much indeed.

Senator HART. Thank you, Senator.

Senator PELL. Is Senator Chiles in the room?

(No response.)

Senator PELL. If not, we will start with the first panel, and I would ask Dr. James Rutherford, Mr. Bill Aldridge, Dr. Stephen Willoughby and Dr. David Leeson if they would come forward, with the understanding that, as a matter of Senatorial courtesy, when Senator Chiles comes, they would step to one side.

Dr. Rutherford?

STATEMENT OF F. JAMES RUTHERFORD, CHIEF EDUCATION OFFICER, AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, WASHINGTON, D.C.; BILL G. ALDRIDGE, EXECUTIVE DIRECTOR, NATIONAL SCIENCE TEACHERS ASSOCIATION, WASHINGTON, D.C.; STEPHEN S. WILLOUGHBY, PRESIDENT, NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS, WASHINGTON, D.C.; AND DAVID B. LEESON, PRESIDENT, CALIFORNIA MICROWAVE, INC., SUNNYVALE, CALIF., AND MEMBER, BOARD OF DIRECTORS, AMERICAN ELECTRONICS ASSOCIATION

Dr. RUTHERFORD. Thank you, Mr. Chairman.

It is a pleasure to be here, especially in contrast to some former years when my colleagues and I were here and found that it was difficult to get attention on these matters. I am just delighted that the Congress of the United States is really taking the leadership in this matter.

I would like to submit my testimony and deal with three points, if I may.

Senator PELL. Thank you.

Dr. RUTHERFORD. The first has to do with the current set of proposals in both Houses. I think that these are timely; I think they address in a beginning sort of way the issue that confronts us, and I do urge that the Congress, and the Senate, in particular, design a bill that will parallel what is in the House, so that by the time this Congress has finished its work, it will be possible actually to have a bill and be on the way.

[Whereupon, Senator Stafford resumed the Chair.]

Senator STAFFORD. Dr. Rutherford, with apologies from Senator Pell and myself, we see that Senator Chiles has come in. Would the panel be willing to step aside, or lay the matter temporarily aside, as wc say here, and allow Senator Chiles to testify?

Dr. RUTHERFORD. Yes.

Senator STAFFORD. Senator Chiles, we are very happy that you found time on an extraordinarily busy morning for all of us to appear here.

STATEMENT OF HON. LAWTON CHILES, A U.S. SENATOR FROM THE STATE OF FLORIDA

Senator CHILES. Thank you; I appreciate it. I am sorry that I was a minute late.

Mr. Chairman, H. G. Wells compared human history to the race between education and a catastrophe, and I think he made a good point. When you look at how fast this math and science legislation is moving, you would think that catastrophe is going to win the race unless we get the bill enacted right away.

I think there certainly is a need for immediate action to close the math, science, and high technology skills gap. It is the key to one of our most pressing economic problems today—unemployment, dislocated workers, low productivity, and lack of competitiveness in world markets.

It is certainly something that we have neglected too long, and we are paying a price now and we will pay a higher price if we continue to neglect it.

I think it is encouraging to see the consensus in Congress that math and science education is a high priority. We all want an effective Federal initiative to support what the State and local educational agencies and the private industry are doing.

I certainly commend your subcommittee and my colleagues here for your commitment and efforts, and I appreciate the opportunity to participate in the dialog. In a couple of weeks, I am going to be introducing my bill on this subject.

Since I am on the Budget and Appropriations Committees and not on the authorizing committees, I very seldom introduce legislation to authorize education programs. But from my work on the funding committees and on the Governmental Affairs Committee, I have a great deal of interest in trying to see how we direct our resources adequately and effectively to national priorities.

There are two contributions that I hope to make to the dialog on the issues by having a bill. One is to offer a large framework that we can use to identify how we bring about the changes needed to improve math, science, and technical skills; second, to try to offer some mechanisms that we can use in our grants to States to see that the funds are targeted to the problem.

I will have to say, Mr. Chairman, that seeing the number of bills and seeing the speed with which this sort of thing is working, I just implore your subcommittee and us in the Congress to see that we come up with a good approach and not one just because we finally discovered this problem. We all seem to have sort of discovered it and everybody wants to say they are doing something about it; I certainly do.

I am very concerned that we are going to spend a lot of money before it is over and I want to spend it in an effective way.

Senator STAFFORD. Senator, I could respond by saying that we are going to consider all of the bills that are introduced. We hope you will get yours in as soon as possible so we can have it in front of us.

Senator CHILES. We will.

Senator STAFFORD. I am being a little facetious maybe when I say that in view of your position on the Appropriations Committee and the fact that Senator Domenici, who preceded you, is chairman of the Budget Committee, we hope some aspects of your bill and his bill both will be part of the final product. [Laughter.]

Senator **Chiles**. Well, I am on the Budget Committee, too, and so I hear what you are saying.

Senator **Stafford**. We have a double reason, then.

Senator **Chiles**. Yes, and Pete now serves on the Appropriations Committee as well.

Well, my bill is not the only comprehensive piece of legislation that is being offered, and many of our colleagues have offered packages of legislation to deal with the shortage. But I think that we have to adopt a program that takes into account all of the points of intervention and how we allocate our resources to them.

I think we have to look at how those pieces fit together and how all of the education programs work together for better math, science, and technological training. As you know, our problem is not only a shortage of qualified math and science teachers at the secondary level.

The elementary teachers and postsecondary teachers in other fields need assistance in upgrading their math and science skills and understandings of technology. Not only do we need to raise our students' achievement in math and science; we need to get into the whole area of how the new technologies are going to affect their lives and work.

So, efforts to just improve math and science are not enough. We are facing that tremendous gap of workers in the midlevel technical skills. Of course, that calls for fully using our vocational education system that we have in place for retraining in these skills.

We have a lot of experience in education to show the need for a comprehensive approach. We know, for example, that you cannot improve education for handicapped children unless you can get them into the buildings.

Our emphasis on basic math and reading skills is yielding some good results in test scores. It is interesting to see that the tests also show that the kids are learning how to multiply, but not when they should be multiplying. So, basic skills instruction has got to be matched with development of the so-called higher order of skills in analysis and decisionmaking.

Our efforts to provide access to education have to include being sure that we are giving children access to quality education. That is not to say that we should abandon any of the worthwhile initiatives or shift our emphasis in the opposite direction, but it does point out the need to avoid a nearsighted approach.

I think the type of improvements we are seeking here have to do with teacher training, with curriculum development, with research, with vocational education, and even with the overall quality of education and school improvement.

So, our initiative to State and local education agencies, to colleges of education, and to industry seems to be to develop a balanced, well-coordinated and integrated system that prepares young people for the technological society in which they live and work.

That need for a comprehensive approach is related to how we work on the Federal budget. We have to look at how much of our resources are directed to education versus health or defense in terms of the needs for each area. But we also have to look at the big national priority, like math, science, technology, and research in education, to see what portion of our resources should be and can be directed there.

Within the big priority are the detailed needs of the various institutions and State and private industry, as well as the part each plays in the overall solution. Within the big priority are the various programs we have in place or will enact to address it. All of it, of course, we are trying to fit together to be effective.

The bill that I am introducing is not all-inclusive; it does not contain additional tax incentives for business or industry to participate or donate equipment. It will not authorize a new direct Federal scholarship or loan forgiveness program. Those are potentially effective ways of addressing parts of the problem. The cost-benefit effect of those proposals, I think, has to be considered as well.

But every form of grant entitlement and tax deduction is a form of spending, and we have to consider the cost of those proposals in terms of what we can afford and what will have the most impact as part of the comprehensive program.

The second feature of the legislation I am going to introduce is the targeting and accountability mechanisms. The problem we are dealing with is a big one; it will take a lot of dollars at every level of Government and private industry over the years to address it.

So, it is not a quick-fix or short-range solution. Teachers do not get recruited and trained overnight. As Dr. Rutherford and others have pointed out, it takes a long time for curriculum changes and new teaching methods to work their way into the classroom.

But at the same time, we cannot repeat what we did after Sputnik went up–put on a crash program and then abandon it. So, I think we are going to need a way to justify the Federal spending that we commit to math and science now and in the future.

The only way to justify this Federal spending is to have a valid national priority, which we do, and to show that the Federal dollars are zeroed into the program in an effective way. Because we need a comprehensive approach to all the interventions necessary does not mean that we can take a single-shot or shotgun approach. I think we are going to have to look at ways that this legislation can do several crucial things.

Each Federal dollar needs to lever State, local and private resources to our highest national priorities in math, science, education and high-technology training. The Federal initiative, at the same time, must not stifle what the States and the private sector are already doing, nor can we burden them with a rigid, inflexible program.

Many of the States are moving out on this, as you know, Mr. Chairman. My State of Florida is considering this in their new legislative session, and they have got a big package of what they are going to do in the State. So, we are not the only ones who have sort of awakened to the problem; the States are out there working on it, too.

So, the Federal dollars need to carry with them some responsibility for the recipients to meet those national needs and gaps and what the States are doing. If we ignore this type of targeting and accountability, we will be sitting here a few years from now faced with the same complaints that I heard when I was running for the first time in the 1970s: Congress is wasteful; Congress throws money at problems; Federal programs discourage State, local and private initiative, and even hinder it, with the strings, the paperwork and the regulations that tell you how to dot every "I" and cross every "T."

I think the way to strike a balance between targeting the money to the problem without rigid restrictions is to give the States a lot of flexibility, and at the same time give them a lot of responsibility in how to use the Federal funds.

The bill I will be introducing will contain a process for the States to plan how they are addressing and will address five or six national priorities. Those include teacher recruitment and retention, teacher training, curriculum improvement, industry needs for workers, access to math and science careers for women and minorities.

The States would have the flexibility to target the Federal funds to their greatest need areas through the institutions that are most effective to address the problem. And then the States would have the responsibility for showing how the Federal funds were being used to address those overall goals.

Under my bill, all the institutions that are a critical part of the answer to our math, science and high-tech skills problem would be included from the planning stage through the participation in the program. That includes the State themselves, local education agencies, community colleges, colleges of education, voc ed, private industry, public interest groups, and teachers.

But rather than tying the hands of the States, saying that 60 percent of the funds must go here and 25 percent or 10 percent somewhere else, the approach that I would make would be to hold the States accountable for directing the funds according to the greatest need areas, whether it is recruiting in that particular State or improving curriculum.

The States would also have to justify their activities in grants according to the involvement and capabilities of the types of institutions selected. All the eligible institutions would have a say in the development of the plan and, of course, there are incentives built in for the institutions and private industry to work together.

As I say, I appreciate the opportunity to be a part of the dialogue on this critical issue. I certainly look forward to working closely with the subcommittee and my colleagues to develop a sound Federal initiative and the appropriate Federal initiative to play its part in the national goal, including the part that we will have to play in the budget and/or Appropriations Committee when we come up with that particular plan.

[The prepared statement of Senator Chiles follows:]

Testimony by

U. S. SENATOR LAWTON CHILES

before the

SENATE LABOR AND HUMAN RESOURCES COMMITTEE

SUBCOMMITTEE ON EDUCATION, ARTS, & HUMANITIES

hearing on

S. 530 and Other Related Math-Science Legislation

H. G. Wells compared human history to a race between education and catastrophe. I think he made a good point. And when you look at how fast this math and science legislation is moving, you would think catastrophe was going to win the race unless we get a bill enacted right away.

There is a need for immediate action to close the math, science, and high technology skills gap. It is the key to our most pressing economic problems today -- unemployment, dislocated workers, low productivity, and lack of competitiveness in world markets. It is something that we have neglected too long. We are paying the price now, and we will pay a higher price in the future if we continue to neglect it.

It is encouraging to see the consensus in Congress that math-science education is a high priority. We all want an effective Federal initiative to support what the States, local education agencies and private industry are doing. I commend the Subcommittee and my colleagues here for your commitment and efforts. I appreciate the opportunity to be a participant in the dialogue.

In a couple of weeks, I will be introducing the Math-Science-High Technology Skills Act of 1983. Since I am on the Budget and Appropriations Committees, and not on the authorizing committee, I do notoften introduce legislation to authorize education programs. But my work on the funding Committees, and on the Governmental Affairs Committee, gives me a great deal of interest in directing our resources adequately and effectively to national priorities.

There are two contributions I hope to make to the dialogue on this issue by having a bill: One is to offer a large framework we can use to identify where and how we can bring about the changes needed to improve math, science, and technological skills. Secondly, I would like to offersome mechanism we can use in our grants to the States to see that the Federal funds are targetted directly to the problem.

My bill is not the only "comprehensive" piece of legislation being offered. Many of my colleagues have offered a package of legislation to deal with the critical teacher shortage, the need for curriculum improvement and research. But we must adopt a program that takes into account all the points of intervention and how we allocate our resources to them. We have to look at how the pieces fit together, and how our existing and new education programs will work together for better math, science, and technological training.

--- Our problem is not only a shortage of qualified math and science teachers at the secondary level. Elementary teachers and postsecondary teachers in other fields need assistance in upgrading their math and science skills and understanding of technology.

--- There is not only a need to raise student achievement in math and science. Students must be taught how new technologies will affect their lives and work.

--- Efforts to improve math and science education are not enough. We are facing a tremendous gap in workers with mid-level technical skills. That calls for fully using the vocational education system we have in place for training and retraining in these skills.

We have a lot of experience in education to show the need for a comprehensive approach.

--- You cannot improve education for handicapped children unless you provide access to the buildings and the facilities.

--- Our emphasis on basic math and reading skills is yielding some good results in terms of test scores. But tests also show kids are learning how to multiply but not when to multiply to solve a problem. Basic skills intruction must be matched with development of the so-called "higher order" skills -- analysis and decision-making.

--- Our efforts to provide access to education have to include being sure we are giving children access to a quality education.

This is not to say we should abandon any of these worthwhile initiatives, or shift our emphasis in the opposite direction. It just points out the need to avoid a near-sighted approach when looking at education. The type of improvements we are seeking here have to do with teacher training, with curriculum development, with research, with vocational education, and even with the overall quality of education and school improvement. So our incentive to State and local education agencies, to colleges of education, to industry must be to develop a well-balanced and integrated system that really prepares young people for the technological society in which they will live and work.

The need for a comprehensive approach is related to how we work on the Federal Budget. We have to look at how much of our resources we are directing to education, versus health or defense, in terms of what the needs are in each area. We also have to look at a big national priority like math, science, and technology research and education and see what portion of our resources should be, and can be directed there. Within the big priority are the detailed needs of the various institutions, the States and private industry, as well as the part each plays in the overall solution. Within the big priority are the various programs we have got in place, or will enact, to address it. But it all has to fit together to be effective.

My bill will not be all-inclusive. It will not contain additional tax incentives for business and industry to participate or to donate equipment. It will not authorize a new, direct Federal scholarship or loan forgiveness programs. These are potentially effective ways of addressing parts of the problem. The cost-benefit of these proposals should be considered as well. But every form of grant, entitlement, and tax deduction is a form of spending. We have to consider the "cost" of these proposals in terms of what we can afford and what will have the most impact, as part of the comprehensive approach.

The second feature of the legislation I will introduce is the targetting and accountability mechanisms. The problem we are dealing with is a big one. It will take a lot of dollars at every level of government and private industry over the years to really address it. There is not a quick-fix, short-range solution.

--- Teachers do not get recruited and trained over night.

--- As Dr. Rutherford and others have pointed out, it takes a long time for curriculum changes and new teaching methods to work their way into the classroom.

--- We cannot repeat what we did after Sputnik went up --- put on a crash program and then abandon it.

So we are going to need a way to justify the Federal spending we commit to the math and science initiative now and in the future. And the only way to justify Federal spending is to have a valid national priority, which we do, and show that the Federal dollars are zeroed in on the problem in an effective way. Just because we need a comprehensive approach, to all the interventions necessary, doesn't mean we can take a single shot or a shot-gun approach.

We are going to need to look at ways this legislation can do several crucial things:

--- Each Federal dollar has to lever State, local and private resources to our highest national priorities in math and science education and high technology training.

--- The Federal initiative must not stifle what the States and the private sector are already doing, nor can we burden them with a rigid, inflexible program.

--- The Federal dollars must carry with them some responsibility for the recipients to meet the national needs and gaps in what the States are doing.

If we ignore this type of targetting and accountability, we will be sitting here a few years from now faced with the same complaints I heard when I walked the State of Florida in 1970 and have concerned the American people throughout the 1970's:

--- Congress is wasteful. Congress throws money at problems.

--- Federal programs discourage State, local and private initiative, even hinder it, with the strings, paperwork, and regulations that tell you how to dot every "i" and cross every "t".

I believe the way to strike the balance between targetting the money to the problem without rigid restrictions is to give the States a lot of flexibility together with a lot of responsibility for use of the Federal funds.

The bill I will be introducing will contain a process for the States to plan how they are addressing and will address five or six national priorities. These include teacher recruitment and retention, teacher training, curriculum improvement, industry needs for workers, access to math and science careers for women and minorities. The States will have the flexibility to target the Federal funds to their greatest need areas through the institutions most effectively able to address the problem. And the States will have the responsibility for showing how Federal funds are being used to address the overall goals.

Under my bill, all the institutions that are a critical part of the answer to our math-science-high tech skills needs will be included -- from the planning stage through the participation in the program. This includes the States themselves, local education agencies, community colleges, colleges of education, voc ed, private industry, public interest groups, and teachers.

But rather than tying the hands of the States, saying 60% of the funds must go here and 25% there and 10% some where else, my bill would hold the States accountable for directing the funds according to the greatest need areas, whether it's recruiting teachers or improving curriculum. The State would also have to justify its activities and grants according to the involvement capabilities of the types of institutions selected. All the eligible institutions would have a say in the development of the plan. And of course there are incentives built in for the institutions and private industry to work together.

As I said, I appreciate the opportunity to be a part of the dialogue on this critical issue. I look forward to working closely with the Subcommittee and my colleagues here to develop a sound Federal initiative, an appropriate Federal initiative to play its part in the national goal.

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Senator **Stafford**. Thank you very much, Senator.

Senator **Chiles**. Yes, sir.

Senator **Stafford**. In seriousness, we can assure you that this subcommittee will review very carefully what you have said and the bill that you will be introducing, and we do intend to come up with a bill at the subcommittee level that combines the best features of all of the legislation that is placed in front of us.

So, we are very grateful to you for helping us this morning at a very busy time for all of us.

Senator **Chiles**. Well, I know this subcommittee has a great deal of expertise and I am sure that you are going to produce a bill that will be sound and beneficial to the problem that we are trying to address.

Senator **Pell**. It would help us, too, if you got the main points of your bill to us as quickly as possible so we can crank it in.

Senator **Chiles**. All right, sir.

Senator **Pell**. I would also add that we very much appreciate the role you play in the Congress both in the Budget and in the Appropriations Committee. So, to get it enacted, we appreciate your position, and afterwards, to make it alive and fleshed out, we appreciate your position.

Senator **Chiles**. Thank you.

Senator **Stafford**. Thank you very much, Senator.

Now, we will resume the panel that was interrupted for Senator Chiles. Gentlemen, our apologies for the interruption. This is a morning of interruptions for all of us. We are going to have a vote on an important treaty in about 7 minutes, which particularly will involve my colleague, Senator Pell, since he is the ranking member of the Foreign Relations Committee.

We will have to stand down during that period long enough for this Senator to get over to the floor, vote, and get back here. So, I will apologize in advance for that second interruption, and without anything further, I guess the bell system was explained.

Senator **Pell**. It was. It would be nice if we could finish the panel before you had to leave for the vote.

Senator **Stafford**. We will try, but that seems a little doubtful.

In any event, Dr. Rutherford, our apologies, and we will start with you again. We understand that staff has advised you that there is a 5-minute limit, if that is agreeable, gentlemen. We never do have enough time to do justice to statements.

Your full statements will be in the record and any material you wish to have included along with them. That stop-and-go thing is something Senator Pell and I see every morning trying to get to work. It just seems like the lights we are looking at take 5 minutes to change.

Anyway, Dr. Rutherford——

Dr. **Rutherford**. The first point is really to commend the notion that Congress is at work; I think that is good. It is important that you report out a bill and get it through the process this year. Generally speaking, the emphasis of the bills seems to me to be the correct one.

My second point is, however, that as I look at those bills, I find them, in fact, to be insufficient, incomplete and not to have the characteristics that Senator Chiles just described. There still is not yet enough thought in them. There are things missing. The magnitude is not yet up to the nature of the task we have before us.

As much as we might like to reform American education with a few cents here and there, in fact it is going to take a very large investment.

The bills are not complete; they leave out children; they leave out talent identification. There is not enough emphasis on research; not enough emphasis on the searching out of minority children; not enough on modernization and on curriculum development.

But it is a first step, and I think if it is recognized that what Congress is up to this year is getting something started in this area, with this recognition that we do not have before us a comprehensive plan, then I think we are moving in the right direction and can look to the future.

Then I would like to turn, in that regard, to the third point, which has to do with the problem of mobilizing resources and managing them. Most of the bills really adopt the plans we have had before. There is talk about the Department of Education and about the National Science Foundation, and how they can coordinate their efforts with 50 States and 15,000 school districts and with libraries and colleges and universities.

That is one of the things about our country; it is very difficult to organize ourselves, to form a direction, to have coherence, and to stick with something long enough to get the job done.

In that regard, then, I would like to offer merely suggestions of the direction that the discussion might take over the next year or so, and the thought that we look for other kinds of solutions to the resource problem and the management problem. Let me offer two examples.

One, I am referring to under the name of the Corporation for Educational Assistance, an agency or an entity to be modeled something after the Reconstruction Finance Corporation or the MAC that got New York on its feet, or perhaps the World Bank; that is, the notion of a place where we accrue the capital that it would take to make an investment in the recapitalization of the educational system to bring about the kind of change that is needed in teaching and learning.

Such an organization, headed by a strong team of people from business, labor, education and science, operated by a CEO of the equivalent of our best people in business and education, would do some of the things that Senator Chiles mentioned.

They would have money available for grants and for loans to States. The States, therefore, instead of having to deal with block grants, which generally are directionless, could, in fact, design programs that would be comprehensive, deal with the problem of teacher salaries, deal with the length of the school year, deal with the curriculum, or whatever was important in that State.

The Corporation for Educational Assistance could provide, then, the additional capital funds that are necessary to carry out an authentic and sophisticated State plan. The money for this fund might very well come from an annual appropriation from the Congress, the issuance of interest-paying bonds, contributions from the private sector that would qualify for special tax credits, and revenues from earmarked taxes on electronic arcade games, which are a multibillion dollar enterprise in America that adds a little to education and utilizes the most sophisticated technologies and the intellect of many of our best people. It seems to me that those funds ought to legitimately and appropriately go back into the educational scene, and it would not at all be onerous when one understands where all those quarters come from to operate those games.

This corporation then would review plans and provide funds for long-term investment in the educational system to provide the decades-long effort it takes to really reform the system in all of its parts.

Now, that would include, in my judgment, finally building a modern communications system in this country to serve the children and teachers; that is to say, an educational communications system that exploits the state of the art.

To that end, I think we should consider EDSAT, the educational satellite, as the center of a national system in which every school and college in the land would have a land receiver—they are not expensive these days—and be connected by cable; that is to say, in which every educational institution, through EDSAT, would be connected to themselves and to the finest scientists and materials developers in the land 24 hours a day.

These materials would be developed, presented and copied on site, utilized at the school's will for the students and for the education of teachers. I would point out to you that there are not enough dollars available to train and retrain all of our teachers simply by the institute method.

I offer these not as pat solutions, but to show that one has to investigate some new mechanisms and ways of thinking about how to obtain the resources and utilize them to do what needs doing. Thank you.

[The prepared statement of Dr. Rutherford follows:]

TESTIMONY TO

THE SUBCOMMITTEE ON EDUCATION, ARTS AND THE HUMANITIES

OF THE

U.S. SENATE COMMITTEE ON

LABOR AND HUMAN RESOURCES

PRESENTED BY DR. F. JAMES RUTHERFORD
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MARCH 8, 1983

Mr. Chairman, I am pleased to testify and give you my views on science and engineering education. My testimony does not represent the position of the American Association for the Advancement of Science on these issues.

Certainly the strength of our economy in the decades ahead depends greatly and directly on two things. First, we depend on the quality of our basic and applied science. Ours is a society that from the very beginning has based its progress on the application of scientific knowledge to real world affairs, and this dependence is increasing. Secondly, our future depends upon how inventive we are at developing new technologies and using them for productive and humane purposes. High quality science and technology are essential to the United States.

How we accomplish strengthening of our economy depends, in turn, upon the education of our citizens. We can do good science and use new technologies inventively only if we are all properly educated. Today, this means that our citizens must have a reasonable grasp of science, along with problem-solving skills, and the ability to understand the relationship of this knowledge and these skills to technology and productivity. It must be noted that this kind of science and technology competency is becoming ever more important for all of our people, not just those relatively few who will become scientists or engineers.

To produce technologically literate citizens will require involving the entire educational system from kindergarten through post-graduate education, and it will cut across all disciplines and fields. The effort must take place not only in our colleges and universities, but also in other community institutions that serve youth and adults. The educational system, in other words, must be redesigned to take science and mathematics education seriously at every level and for all students. The future worker, the future manager, or the future journalist or legislator needs to be scientifically and technologically literate, just as our scientists and engineers must be humanistically educated.

We can have a strong educational system capable of providing such education only if we are prepared as a nation to make a substantial investment over a long period of years. Quick fixes and lopsided or incomplete solutions will not serve the nation or solve the science education problems that have been recognized over the last decade or so.

In the sections below, I will address four issues. These are:

- what needs to be done in order to revamp and maintain our science education capability;
- the nature of the Federal role in achieving that purpose;
- a brief analysis of current approaches to the teacher shortage problem; and
- suggestions concerning the magnitude of the capital investment required and how the resources can be mobilized.

The Task Before Us

The task before us is large. It is complex, and it will be expensive to deal with adequately. This might not be true if we had not allowed the system to become dilapidated and inefficient. Restoring its capability means not only addressing modern demands but also making up for more than a decade of neglect. In what follows I will address only the part of the problem that deals with youngsters in the preschool, elementary, and secondary school years. There is much to be done for our institutions of higher education and for continuing adult education, but because of its urgency, I prefer to focus on the earlier years.

I would like to suggest that there are six kinds of things that need to be accomplished.

1. The first condition for action is public awareness that, given our times, science education is important for everyone as individuals and to the nation as a whole. Our citizens must understand that this is so for very practical reasons. That is because it is connected to job opportunities, a healthy economy, and to our national security. Furthermore, it is necessary that this public awareness be maintained for the long period of time it takes to bring about lasting change in our system. Promoting hysteria will not work because it will not accomplish our goals.

While statements by public figures can help, the most powerful way to raise public consciousness is to begin to undertake direct, clear actions. When the people see their Federal and state governments begin to take action, they are likely to believe that an emergency exists.

2. We need to ensure that the teachers of science and mathematics in our elementary and secondary schools are well-trained specialists. Current public and legislative attention has largely concentrated on the supply and demand of teachers and on teacher quality. Federal and State initiatives are trying to address both the upgrading of teachers already in the system and the preparation of new ones. (Later in my testimony I will point out that, in spite of current proposals, aspects of this problem are still being missed.)

3. The effectiveness of science and mathematics teaching must be increased greatly in our elementary and secondary schools. This means updating the content, modernizing the materials and techniques, and restructuring the system, if necessary. In other words, good teachers are essential, but they are not enough.

4. We must systematically search out young people who are highly interested and talented in science and mathematics and continually motivate and challenge them. We should start with very young children and continue through the high school and college years. Scientific talent has always been a precious commodity and now it is becoming even more necessary in a world of technology based on science. In this regard it is especially important that we develop effective programs for reaching girls, minorities, the handicapped, and the economically disadvantaged; otherwise, the potential pool of future

scientists and engineers will be much too small.

5. Alleviating problems in precollege science education necessarily calls for aggressive emergency measures, but in the long run, building and sustaining a capacity for the conduct of research and development on learning in science is critical. The argument for R&D is based on simple necessity: all other domains, from transportation and agriculture to health and defense, predicate progress on a solid base of scientific knowledge. In the long run we can progress in science and mathematics education only if we are able to understand the learning process more deeply, and to develop better teaching materials and techniques.

6. Finally, it is clear that substantial resources must be allocated and brought to bear in a way that will make it possible to upgrade and maintain our system of science education. Just how much this will be is difficult to say, but surely in the aggregate it will cost of the order of a billion dollars a year for many years, more if we are not prepared to sustain the investment for many years. Even that is a modest amount in comparison to the magnitude of the enterprise. Education in America is about a $120 billion a year investment, and research in the nation costs a few tens of billions a year. As nearly as one can tell, the funds earmarked for restoring science and mathematics education in the Nation are no more than a few hundred million at most. Thought of as capital investment in our country's scientific and technological future, the current and proposed expenditures are small.

The Federal Role

It is a truism that the cost of education must be borne by many institutions and parties. It is difficult to assign costs and responsibilities in any precise way. It is possible, however, to define the Federal role. I would suggest that Federal leadership is appropriate whenever:

- the necessary action is Federal by long and accepted tradition;
- the costs are beyond the resource capabilities of the States and the private sector;
- Federal manpower needs are at stake;
- achieving national equity is an issue; or
- the main value comes by virtue of being Federal.

By those criteria, it makes sense now--as it did in the past--for the Federal government to take the lead in the following kinds of activities that by and large are not being provided for at all, or at a sufficient level, in the current bills:

- talent identification and motivation, especially among girls and minority youth;
- science television programs for children at all grade levels;
- public understanding of science efforts of science centers, public libraries, and the media;
- the design and testing of new courses and materials for science teaching and learning;
- the expeditious but sensible exploitation of new information and commu-

nication technologies in behalf of better science and mathematics education; and
- research and development in science education.

Teacher Preparation

How science and mathematics teachers go about their work and with what resources may change in the future, but nothing on the horizon even suggests that their role will be diminished. Thus, it is urgent that some legislation be passed in this Congress so that we can begin to deal with the problem of helping the teachers upgrade their subject-matter knowledge and their ability to teach it.

Viewed in the long run, however,there are, I believe, several shortcomings in proposed legislation that remain to be dealt with. Some of these are:

- The aggregate authorization in most proposed bills, whether matched or not by state agencies and private sources, is small compared to the magnitude of the need. A few weeks of summer study once every decade or so is not enough to bring teachers up-to-date and keep them there. The cost of seeing to it that all of the unprepared, the poorly prepared, and the formerly prepared teachers of science and mathematics are brought up to standard, and then that they all receive additional training periodically, is many times higher than the sum total of what is now being proposed.

- Many of the proposals call for state and private matching of funds. This is a reasonable idea conceptually, but it is clumsy in operation and it favors the wealthy states and those that have a profitable industrial base. It is as important for the teachers in the poor states, perhaps even more so than in the wealthy ones, to receive intensive and periodic training.

- Proposed legislation does not distinguish between two related, but quite different dimensions of the problem: (1) the recognition and advanced training for the very best teachers, and (2) the general upgrading of the entire science and mathematics faculty in individual schools. For the former teachers, NSF institutes of the kind that used to be held in the nation's greatest research universities and in which the participating teachers were selected in a national competition and paid stipends, are especially effective. They bring to the teacher the prestige of NSF, the satisfaction of having been selected on the grounds of merit, and the reward of attending great institutions, however far they might be from one's residence. But to improve the quality of science and mathematics instruction in a given school requires that all teachers of those subjects receive full attention. This can be accomplished best through the kind of instruction that is operated through the states and local school districts as part of a systematic multi-year plan, with the Department of Education serving as the major funding agency.

- The proposals are not facing up to questions of effectiveness and efficiency. If we are really to serve the continuing education needs of our teachers, year after year, we must develop an electronic capability to supplement and implement traditional study opportunities. This is to say we should now invest in a system for delivering teacher education to the teacher at his school or home that uses video tapes, audio tapes, computer programs, and the like. Such devices will make it possible for teachers to stay up-to-date in content and technique through personal study and, if necessary, demonstrate this through periodic external examinations. Such a modern system could have associated with it periodic university study and experience in industry and science museums. To accomplish this, it would be necessary to invest not only in the delivery system, but also in the creation of effective teacher training materials. There needs to be, therefore, legislation authorizing grants to universities, science museums, and scientific societies to provide these materials.

Mobilizing Resources

Like it or not, it will cost billions of dollars to restore vitality to the nation's science education enterprise. Proposed Federal legislation calls for only a few hundred million. Some States are making investments, but many are not, and many in fact are reducing educational expenditures. Where, then, are the funds to come from to do the job, and how can the job be managed?

The management question comes up because there are so many players in the game. On the Federal side there are several agencies (the Department of Education and NSF are the most prominent, but not alone) and several Congressional committees that have a legitimate interest in helping to upgrade science education. After that, we are dealing with 50 states, many of which divide the responsibility in smaller regional units, and some 15,000 separate school districts presided over by independent school boards. Private business and industry vary greatly from place to place in what they are doing to assist education. The foundations, public libraries and science museums, colleges and universities, numbering in the thousands, have a part to play in science education, as have the nation's scientific, mathematics, and engineering societies. How, then, are we to marshal resources and achieve national purposes, given such dispersion of authority?

As a start in finding an approach that acknowledges the capital investment character of the problem, the need for Federal leadership and the crucial reality of State and local implementation, I would like to suggest that Congress consider creating what I will refer to here as the Corporation for Educational Assistance. This, or some such organization, might have the following features:

- It would be quasi-governmental, modeled after such predecessors as the Reconstruction Finance Corporation instituted by President Hoover, the Municipal Assistance Corporation which provided a mechanism to get New York City back on its feet, and the World Bank. It would be conceived of as a stable, Federally backed financial agency prepared to help the States design and implement hard-headed plans for strengthening science education.

- Like such organizations, and perhaps also the Corporation for Public Broadcasting, CEA would serve purposes defined by Congress, but would be managed by a board of trustees made up of distinguished leaders from business, labor, education, and science. It would be headed by a chairman and a CEO equivalent to the most distinguished business, financial, and educational institutions in the United States.

- It would itself be capitalized with funds from several sources. These might include:

  - a fixed annual appropriation from Congress,

  - the issuance of interest-paying bonds,

  - contributions from the private sector that would qualify for special tax credits,

  - revenue from an ear-marked tax on electronic arcade games. (This alone might provide something like several hundred million dollars a year, and would not be onerous.)

- The Corporation would review plans to improve science and mathematics education of the individual States, regions, and cities. The emphasis would be on long-term planning by the States and would necessarily take into account local circumstances, financial and educational. The Corporation for Educational Assistance, through its lending authority, could help provide States with improvement capital.

- Since the focus of CEA would be long-term investment and making capital available, the functions of other Federal and state agencies could continue unabated. The NSF would still fund R&D, merit teacher fellowships, science museums, and the like; the Department of Education would provide funds for the development of national television programming for children, teacher training institutes, dissemination, etc.; the NIH would underwrite the development of instructional materials relating to health, and so forth.

The second idea I would like to present to you has to do with the quality and availability of continuing teacher education. The nation's teachers, as has already been suggested, and the nation's children need to have available a modern system for learning. Such a system would have several elements, including:

- a dedicated satellite (EDSAT), available for 24 hours a day exclusively to serve the educational needs of all of our students and teachers.

- a combination of land stations and cable connections that would link every school and college to EDSAT.

- the development in many different universities, schoolrooms, television stations, museums, laboratories, etc., of instructional programs and materials for science teachers and their students, and eventually for students and teachers of all subjects. In addition to program material to supplement science and mathematics teaching at all grade levels, EDSAT could transmit such unusual fare as daily science news for the classroom, ideas for student activities, math competitions, special events, etc. All broadcasts could be automatically video-taped on the premises (day or night) and used by teachers and students in accordance with their own individual situations and preferences. Needless to say, material could be made available in this way to colleges, homes, libraries, and museums.

— computer capability in every school. One or two computers per school will not do, nor will the computer be of much use, however many there are, if there is not good software to use with them, or if the teachers are not trained to use them effectively. Any effort to modernize schools technologically must include plans for producing computer materials for training the teachers, as well as for children.

Under present circumstances some of these things will be done in some places, but, viewed nationally, progress will certainly be hit or miss, unsystematic, and unnecessarily expensive. The Federal government should consider assigning NASA the responsibility for designing, launching, and maintaining this national educational communications system. The costs and responsibility for the development of materials themselves could be lodged in other agencies, such as the Department of Education and NSF. The management of "EDSAT PLUS" could be modeled after COMSAT, or made the responsibility of an Education Communications Authority. The purpose, in any case, would be to set as a national goal the technological modernization of teaching, and to set up an agency to build a nationwide system of communications linking the schools and colleges of America to each other, to the scientists, engineers, and mathematicians of our nation, and to the most creative producers of science learning materials.

These two ideas--a Corporation for Educational Assistance and EDSAT--have not been worked out in detail. I present them to this Committee because I believe that eventually we must look to such mechanisms as ways to mobilize our financial and intellectual resources in behalf of the scientific learning of our young people.

Senator **Stafford**. Thank you very much, Dr. Rutherford.

Mr. Aldridge, we would be glad to hear you.

Mr. **Aldridge**. Thank you, Mr. Chairman. For the record, I would like to begin by noting that the data which has documented this crisis has come from only two sources, principally from the National Science Teachers Association, and second from Howe and Gerlovich of Iowa State. None of that data came from the National Science Foundation.

I am saying this because one of the serious problems we had was spending 3 years convincing the Congress that we had a crisis because the National Center of Education Statistics had not provided documentation, and neither had the Science Resource Studies Group at the National Science Foundation.

With that, I would like to cite some of the more recent results of our studies, but not repeat most of the statistics which you have all heard so frequently.

There clearly is a catastrophic drop in the number of people prepared to teach science and mathematics in the secondary schools. In addition, there are at this time large numbers of unqualified teachers in the classrooms—something like 30 percent of the teachers in science and math classes.

We know that a substantial number of these are reassignments from social sciences, physical education, home economics, and so forth—reassignments because of surpluses in those areas and the inability of schools to employ qualified people because of the shortages.

We also know that in this present school year, something like 640,000 children were not able to take a science or math course because the classes were not scheduled in order to schedule courses other than science or math for those surplus teachers; we have evidence of that.

We know that among the 17 million children in grades 8 to 12 this school year, 6.3 million are not taking any science at all, and 6.4 million are not taking any math.

One of the more serious problems that we recognize and we feel is not adequately addressed in the legislation that we have seen is the matter of outdated courses and course content.

What we have today in the schools was designed originally for those persons who would become scientists and engineers. It now is outdated and obsolete even for that audience. It has not served at all those 95 percent of the population who do not intend to become scientists or engineers. So, something important needs to be done in this regard.

We recognize the fact that there is a local responsibility for the delivery of education, and we recognize the State responsibility in preparation of teachers, and we recognize that the Federal responsibility comes in only when we face such a crisis as we now see.

Nevertheless, you have an agency in the Federal Government which has a mission to support science education at all levels. Almost as a direct consequence of the negligence of that agency, we face the present situation; that agency is the National Science Foundation.

The constituency of the board that offers policy for that agency is almost entirely made up of people who are research scientists or benefit from research science. There was a science education directorate in that agency at one time; that has been eliminated by the administration. Funding has dropped to something like 2 percent of its total level.

When we look at the various bills that have been introduced in the last session of Congress and in the more recent session, the one that seems to hold the most promise from our standpoint is H.R. 1310, just passed in the House. It received overwhelming approval, something like a two-to-one margin even by the minority party in the House.

We believe that it addresses most of the problems, and addresses them adequately, as a start. We have some concerns about the block grant program. We also have serious concerns about lodging any kind of research or development effort at the National Institute of Education until some resolution occurs in regard to the idealogues and the problems you are very familiar with, Mr. Chairman.

We believe very strongly that NSF has the capability of linking the scientists and the science education people and the teachers in a cooperative way to produce quality products in course materials and course development, and we believe that they can offer the kinds of training programs for teachers that will spend Federal money most efficiently. So, we would strongly support those components of H.R. 1310.

In summary, what we are recommending is that the Senate, as quickly as possible, put together some kind of appropriate companion measure to H.R. 1310, get it out of this committee onto some kind of a fast track, and get legislation approved so that by the fall, both the Department of Education and the NSF can have programs up and ready to run.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Aldridge follows:]

TESTIMONY

TO

THE SUBCOMMITTEE ON EDUCATION, ARTS, AND HUMANITIES

OF

THE COMMITTEE ON LABOR AND HUMAN RESOURCES

OF

THE U.S. SENATE

IN REGARD TO

THE RESPONSIBILITIES OF FEDERAL, STATE, AND LOCAL JURISDICTIONS IN ADDRESSING THE CRISIS IN PRE-COLLEGE SCIENCE AND MATHEMATICS EDUCATION

PRESENTED BY:

ROBERT E. YAGER
PRESIDENT
NATIONAL SCIENCE TEACHERS ASSOCIATION
1742 CONNECTICUT AVENUE, NW
WASHINGTON, DC 20009

WITH:

BILL G. ALDRIDGE, EXECUTIVE DIRECTOR
NATIONAL SCIENCE TEACHERS ASSOCIATION

March 8, 1983

ROBERT E. YAGER

Robert Yager was prepared as a high school teacher of science--graduating from the University of Northern Iowa in 1950 with a biology major and a teaching certificate. He taught science in grades 7-12 before entering graduate school at the University of Iowa. He earned an M.S. (1953) and a Ph.D. (1957) in plant physiology/biochemistry. After earning the doctorate, Dr. Yager decided against a life as a researcher in physiology and opted for a career in science education while retaining close ties with the active research team in physiology at the University of Iowa.

Dr. Yager created one of the largest and most productive science education centers in the U.S. He has advised nearly 100 Ph.D. candidates, authored over 200 research reports, directed over 100 NSF, OE, and various Foundation research, development, and training projects. He has been active professionally having served on numerous boards, commissions, and panels; he has been the president of the Iowa Academy of Science, the School Science and Mathematics Association, the National Association of Biology Teachers, the Association for the Education of Teachers in Science, and the National Association for Research in Science Teaching. Currently he serves as the President of the National Science Teachers Association, the world's largest science education society with over 40,000 members and subscribers.

BILL G. ALDRIDGE

Bill Aldridge took dual undergraduate majors in physics and science education. He then taught high school physics and math for six years. After completing three graduate degrees in solid state physics, educational evaluation and science education at Kansas and Harvard, he taught physics at the college level for seventeen years.

Mr. Aldridge has directed three NSF course development projects in applied physics, technology, and modern electronics (including computers). In addition, he served a three-year assignment (1976-1979) from his college to the Division of Science Education Development and Research at NSF as a Program Manager before taking his present position as Executive Director of the National Science Teachers Association. Mr. Aldridge has published science and math textbooks and numerous articles in magazines and journals. He has served in a variety of capacities on advisory boards, committees, etc., and he is currently a member of the Scientific Manpower Commission. The National Science Teachers Association, which he directs, is the largest science education organization in the world, and it is concerned with the professional aspects of science teaching at all levels.

INTRODUCTION

There has been a perception that the science education community lacked consensus on what should be done to resolve the problems in pre-college science and mathematics education that NSTA and others have documented. Recently, presidents and executive officers of the National Science Teachers Association, the American Association of Physics Teachers, the National Association of Biology Teachers, and the National Association of Geology Teachers formed a group called the Council of Science Teaching Associations. The education division of the American Chemical Society is also represented on our Council, although we are not permitted officially to represent their views.

The Council of Science Teaching Associations represents science teachers, science administrators, science educators, and teaching scientists at all levels. Thus the Council is fully representative of the subject matter disciplines--physics, chemistry, biology, and geology--at colleges and universities, as well as science teachers in these fields in elementary and secondary schools. Council organizations also include local science supervisors, state science supervisors, as well as those in schools of education who train science teachers. No other organization or group either includes this representation or reflects our views on the professional aspects of science education accurately.

The crisis in science education at the pre-college level has received widespread publicity. As the primary source of data documenting the crisis, the National Science Teachers Association has been deluged with requests for detailed information and suggestions for solutions.

The NSTA data have been collected through several different surveys conducted over the past three years. Through these survey results and other studies, the crisis in elementary and secondary school science and mathematics education can be summarized as follows:

1. There are shortages of qualified secondary school science and mathematics teachers. The shortages are critical in mathematics and in physics;

2. There is a serious mismatch between existing secondary school science and mathematics course content and the needs and interests of the vast majority of students; for those students who would aspire to careers in science or engineering, course content is obsolete;

3. There have been few attempts to alter instruction in schools in ways consistent with the growing body of new knowledge about how people learn science or mathematics;

4. Supplies, equipment, and other resource materials are severely limited or obsolete in most science classrooms and laboratories; those that exist are inappropriate to the science course content and teaching methods needed to update pre-college science education;

5. In elementary school offerings, science content is nearly nonexistent. Teachers are ill-prepared, resources are lacking, and the focus is on the so-called "basics" which have tended to ignore science.

The Shortage of Science and Mathematics Teachers

Supply

The shortage of science and mathematics teachers is documented by looking at supply and demand. The NSTA fall 1981 survey of 600 colleges and universities which prepare science and mathematics teachers showed a shocking ten-year decline: a 79 percent decline for mathematics and a 64 percent decline for science. (See attached paper by Shymansky and Aldridge.) Data from the NSTA fall 1982 survey show a further decline. (See attached graph.) According to NCES data, the decline over this same period for teachers in other fields was only about 25 percent, and the decline in students was even less, about 20 percent.

Demand

The demand for science and mathematics teachers has been documented by Howe and Gerlovich at Iowa State in surveys of state science supervisors. NSTA derived "demand" data from surveys of secondary school principals. Our fall, 1982, survey showed that secondary schools employed 2 percent more science and mathematics teachers in 1982-1983 than in the previous year. With widespread calls for increased requirements for science and mathematics in high schools, we can expect further increases in the demand.

Use of Unqualified Teachers

Given that the supply of science and math teachers has dropped so drastically, how can the schools be finding teachers to fill classes? They have been employing unqualified or underqualified teachers. Last year half of the newly employed science and mathematics teachers in the U.S. were unqualified. Hiring such teachers is made possible through provisional or emergency certification, or through extremely low certification standards. The emergency measures have made possible the reassignment of teachers from physical education, home economics, social science, elementary education, and other fields where surpluses exist. A more common problem is transferring teachers within science, that is, from biology to chemistry and physics, without sufficient qualifications in those subjects. Over 30 percent of all science and mathematics teachers in grades 7-12 are unqualified or are severely underqualified to teach the subjects they have been assigned.

When promising but underqualified teachers are taken from the elementary school and reassigned to secondary schools, the situation is doubly tragic. The secondary school science or mathematics students are instructed by an unqualified teacher while the elementary school students lose a teacher with promise in mathematics or science. The situation at the elementary school level is especially serious, and we need teachers at that level with interest in and some knowledge of science or mathematics.

Principals are faced with an overall declining secondary school enrollment, a surplus of teachers in some areas, and a shortage of science and mathematics teachers. Who can blame a principal who reassigns a long-time faculty member from a non-science field into a science or math slot when no qualified teacher can be found? Moreover, even if a qualified person were available, tight budgets and teachers' contracts may preclude a principal from hiring a new staff member; thus the principal is forced to meet the need through staff reassignment.

Not Offering Needed Science & Mathematics Courses

The demand for science and mathematics teachers is even greater than indicated by open positions. According to NSTA's fall, 1982, survey results, for lack of teachers and/or resources, some 32,000 classes in science and mathematics were needed, but could not be scheduled in 1982-1983. Instead, some 640,000 children who wanted to take science or mathematics were required instead to take courses in other subjects for which no teacher shortage existed. Of the 17 million children in grades 8-12 this school year, 6.3 million are not taking science, and 6.4 million are not taking math.

Magnitude of the Problem

Supply of New Teachers

Approximately 4,000 of the 7,000 persons prepared to enter secondary school science and math teaching positions for 1982-1983 actually accepted teaching positions. The schools hired 12,500 entirely new science and math teachers to replace those who retired or left for non-teaching employment. In addition, 8,700 changed employment from one school to another. These data suggest that some 8,500 teachers, or 68 percent of those employed, were from sources other than colleges and universities that train teachers. These sources include business and industry, but mainly other teaching fields, like physical education, social sciences, home economics, etc. Many states are considering increases in science and math requirements. A one-course increase in either science or math in the nation's schools would require a 20 percent increase, or 40,000 more science and math teachers. Where will they come from?

Unqualified and Underqualified Teachers

Some 30 percent of the present secondary school science and math teachers are unqualified or underqualified, amounting to 60,000 teachers. Since half or more of the newly employed science and math teachers are unqualified, within 6 years, half of all such teachers in the schools will be unqualified or underqualified. Even if federal or state scholarships or loans could be awarded by the fall of 1983, before these students could graduate, 4 years later, the number of unqualified or underqualified teachers will have reached 44 percent.

Re-Training Unqualified Teachers

There are about 10,000 secondary school science and math teachers in the U.S. who are completely unqualified. Those in public schools have no certification, not even on an emergency or provisional basis. These teachers typically have never studied the subject they have been asked to teach, or those studies have included at best one or two introductory college courses.

If these teachers are to remain in the classroom, they need an intensive program of evening and Saturday course work during the school year, plus full-time study during the summer. They need individually designed programs of two or three years in duration, to allow for sequences of courses in math and science.

Since about 2,000 of the 12,000 science and math teachers who are newly employed each year are completely unqualified, the number needing retraining will increase by 2,000 per year until the supply of qualified teachers can be increased. This will require retraining a number larger than 10,000 and over a longer period of time than three years.

Upgrading Marginally Qualified Teachers

There are about 50,000 underqualified or marginally qualified science and math teachers in secondary schools of the U.S. This number is increasing dramatically each year. These teachers could be helped greatly by summer institutes, workshops, short courses, or part-time study during the academic year.

The Outdated Curriculum

The lack of sufficient numbers of trained teachers is compounded by the mismatch between science and mathematics courses and the needs and interests of students.

The science and mathematics courses in U.S. schools today are, for the most part, only slightly modified versions of those developed after Sputnik by teams of scientists and teachers. Yet, as Jerrold Zacharias, MIT physicist, and originator and developer of one of the first National Science Foundation course projects, PSSC Physics, said,

> "We had aimed only at the college-bound and college students because we could not do everything at once" (in testimony before the Subcommittee on Science, Research, and Technology of the Science and Technology Committee on February 19, 1980).

Our present science and math courses neglect the needs and interests of the vast majority of students. They focus on pure science and are largely devoid of practical applications, technology, or the relevancy of science to society's problems. They do not prepare people to enter the myriad of non-science occupations, which require general technological knowledge for which science is the base. Nor do these courses properly take into account the utilization of the computer and modern electronics.

Technically well-trained people are needed by emerging or rebuilding industries to solve the economic problems we face.

The science and math courses in most schools have instructional and laboratory materials of the 60's, and they are obsolete! They don't even meet the needs now of those students who would become scientists and engineers.

New Instructional Strategies

The last ten years have provided much new information concerning the way humans learn. The current literature provides exciting new information concerning the adolescent mind, and how it grows and develops. Information from studies in cognitive psychology need to be applied in school science classrooms. Various new studies on the structure of the sciences themselves suggest different approaches to instruction, and new ways for science teachers to approach their tasks. Use of current research in all areas is needed as teachers are retrained.

Federal, State, and Local Responsibilities

The delivery of pre-college education is clearly a state and local responsibility in the United States. Teacher salaries, as well as normal supplies, materials, and equipment for science and math instruction must remain a local and state responsibility.

The federal responsibility for pre-college science and math education should be mainly at two agencies: The Department of Education and the National Science Foundation.

The Department of Education, through grants to State and Local Education Agencies, and through programs at NIE, can play an important role in addressing the science education crisis. In both the Administration's initiatives for 1984, and in H.R. 1310, funds are provided to address the science and math teacher shortage. A few states also have recently begun programs to increase the supply of such teachers. As a general principle, we would agree that pre-service training of science and mathematics teachers should be mainly a state and local responsibility, although in times of crisis, state and local funds should be augmented by federal support through the Department of Education. We would further agree that routine and continual in-service education programs for science and math teachers should be a local responsibility. but, again, in times of crisis, funding should be augmented by federal support through the Department of Education. The private sector should focus mainly on local and community assistance through provision of matching funds, resources, and personnel. Tax credits (as in the Glenn-McCurdy bill) would help stimulate private sector support.

In educational research, we believe that the NIE should be principally responsible for basic research on learning and on the use of various technologies to facilitate learning. The NSF should be responsible for research on the structure of course content in science and mathematics fields as well as research on the applications of basic research in learning science and mathematics that would result from NIE-supported basic research.

Curriculum research, which would focus on selections of content and sequence, K-16, should be a responsibility of the NSF. But creating curricula--that is, the selection of content and decisions on sequence, must be a local and state responsibility.

Why Support of Research, Development, & Teacher Training Programs Should be Lodged at NSF

In deciding on NSF's responsibilities, we would agree with Senator Jake Garn's recent statement in a letter to the NSF director:

> "The specific functions that we believe are appropriate for NSF are: materials development; public awareness and motivation; teaching and materials demonstrations; evaluation of materials and teacher training; research in learning and cognition; and high technology applications."

The NSF responsibility and authority is described in Public Law 507-81st Congress (64 STAT. 149, S. 147), Section 3.(2):

> "The Foundation is authorized and directed - (1) to initiate and support. . .science education programs at all levels. . ."

In spite of lack of action on the part of the National Science Board in carrying out this statutory obligation, we in science education contiue to believe firmly that the original reasons for lodging science education programs at NSF are still valid and important.

We must develop science and mathematics education materials and train our teachers in a partnership with those scientists who create the knowledge. That knowledge, and the methods used by scientists to acquire new knowledge, are constantly changing. Science and mathematics teachers need direct, cooperative relationships with scientists and mathematicians, and involvement of research scientists in science education is essential. The NSF is a small independent agency with a reputation for administering programs of very high quality selected on merit.

Even though the National Science Board has been slow to respond to the present crisis, as indicated by the lack of NSF initiatives, scientists at universities and in the private sector, as well as those at the AAAS and the National Academy of Sciences, have shown great interest and concern. Many of these persons are actively working to improve the situation.

The Need for New Course Material

The NSF course development projects of the 60's were excellent for their purpose. They developed courses, materials, and labs to prepare persons who would become research scientists and engineers. Until they became obsolete--which they did about ten years ago--these courses were excellent. But they evolved into essentially all present-day physics, chemistry, earth science, and biology courses and texts which are obsolete and inappropriate to the needs of the vast majority of students.

Rather than try to develop course content in each of the 16,000 school districts of the U.S., which would be wasteful and inefficient, and for which we could never assemble the needed concentration of expertise, it is important to have national efforts. The local schools can build their curricula by selecting and sequencing from among a variety of high quality and appropriate alternatives. National efforts have the benefit of widespread involvement of thousands of teachers in field trials and evaluation, assuring local school input into alternatives which are produced. Local schools also can adapt nationally produced materials for their special needs.

We need national course development efforts with teams of scientists, science teachers, science educators, and learning specialists, working in cooperation with publishers, equipment manufacturers, and computer and software companies. These course development projects should design courses with applications and labs that use modern microelectronics and computers.

Building Science Education Leadership

In one of our projects at NSTA, the Search for Excellence in Science Education, we have discovered important information about the teachers who have been leaders in creating excellent programs. Their average age is 51, and they have been teaching 17 years. These were the people who began their careers immediately before Sputnik and who participated most heavily in NSF institutes and projects.

If the nation is to build leadership and concentrate on meritorious programs, funding initiatives must increase the size of this leadership pool. Thus, there should be a national program component at NSF aimed at providing support for our best science and math teaching personnel to participate in conferences, workshops, institutes, and advanced degree programs.

The NSF has the staff, the organization, and the experience in research, development, teacher institutes, and undergraduate programs. Even with the severe reductions of staff in science education, many remain who were associated with development, course improvement, teacher education, and public understanding of science. The NSF has offered important programs through TV (3-2-1 CONTACT, NOVA, etc.), science museums, and other media to inform and educate both youth and adults in science education.

Federal Initiatives

In the last session of Congress, there were some 17 bills introduced to address the crisis in science education. In the current session several of these have been reintroduced, and others are being prepared.

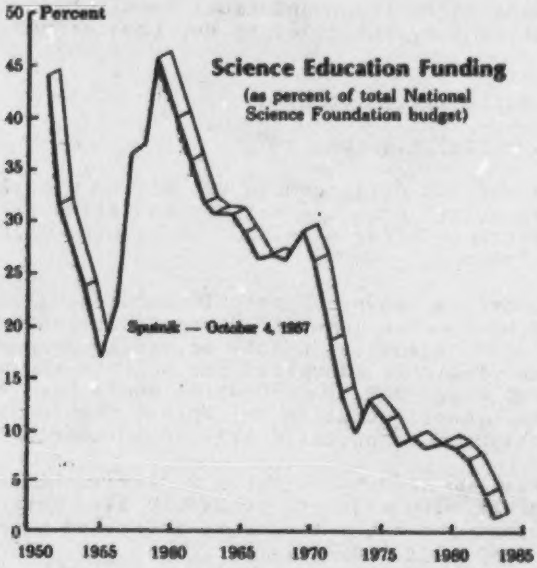
National Science Board Neglect

The NSF has the authorization to maintain the health of science and the science education which feeds science. The existence of the present crisis and the variety of Congressional initiatives are clear evidence that the NSF policy-making body, the National Science Board, has been negligent over a long period of time. They set policy and recommend programs and budgets to support those programs. In an effort to protect and promote support for scientific research, the NSB has systematically reduced support for science education over a twenty-year period. We now face the consequences of that long-term neglect.

Jerrold Zacharias, former MIT Research Scientist, has stated the problem with the NSB well:

> ". . .the Education Directorate [at NSF] is struggling against an almost impossible enemy--an enemy from within. From its inception the Science Board [NSB] that supervises the NSF has treated the Education Directorate as a trivial country cousin. They have said that the government should give the NSF money for scientific research and never mind what happens to the two hundred million people who don't do research. It is those very people whose lives, jobs, leisure, entertainment, food, security, and everything else depend on a sound economy in a democratic society. The federal government can no longer allow itself to neglect the schools, and the NSF has in its charter the responsibility and authority to do something about them."

The following graph shows clearly how science education programs were allowed to deteriorate.



Reconstituting the National Science Board

Although the statute governing the NSB appointments makes clear that eminent persons from science education should be among Board members, the NSB is heavily dominated by research scientists, university administrators, or persons representing other sectors that directly benefit from scientific research. We have no desire to place on the Board "educationists" or educators who do not know science. Although there are many outstanding and eminent persons in science education, including persons with superb scientific credentials, none are included on the NSB. Science education includes science teachers at all levels, local and state science supervisors, and the science educators who do research on how people learn science and math. It also includes those in schools of education who prepare secondary school teachers. Many of these people have excellent Scientific credentials, as well as experience and knowledge in science education. There is no valid reason for excluding such persons from the policy making body of an agency having as a major mission science education.

The Senate should direct the NSF to honor the enabling legislation which requires an appropriate balance of NSB members, to include persons with science education knowledge and expertise. We should not, as in the past, be forced to rely entirely on the oversight and wisdom of Congress to impose science education programs on an agency which has that function as a primary mission.

Re-establishing a Science Education Directorate

If The NSF is to accept its responsibilities for science education "at all levels", then the Science Education Directorate, which was eliminated by the Foundation, should be re-established by statute, as was done by the House of Representatives last year.

Congressional Initiatives for 1984

H.R. 1310 - $425 Million

Among the various Bills coming out of the U.S. House of Representatives relative to the science education crisis, one stands out as most likely to offer promise. It is H.R. 1310, and may be summarized as follows:

H.R. 1310 merges two previously introduced bills, Perkins' H.R. 30 which would have given money to State Education Agencies (SEAs) and Local Education Agencies (LEAs), primarily as entitlements, and to institutions of higher education for science and math instruction improvement, and Fuqua's H.R. 7130 which would have given money to institutions of higher education to improve the country's production of scientifically and technically trained personnel.

At 7:20 p.m. on Wednesday, March 2, 1983, the House passed H.R. 1310 by an overwhelming majority of 348 to 54. There was strong bipartisan support for the measure, as indicated by almost a two-to-one Republican vote for the Bill.

Title I of H.R. 1310 provides up to $250 million to states (and through them also to the LEA's) for needs assessment and planning, then personnel training, and then purchase of equipment, etc. In addition, H.R. 1310 provides an appropriate division of responsibility between NSF and the Department of Education in other areas where support is needed. The Education Department will receive $20 million for 5,000 one-year scholarships, $5 million for Minority Institutions Improvement, and another $20 million for institutes. The NSF will receive $10 million for course improvement programs, $15 million for institutes, and $5 million for research in science and math education. The NSF will also receive another $100 million, $15 million of which is for pre-college improvement, $20 million for community colleges, $15 million for college instrumentation, and $50 million of discretionary funds for postsecondary and graduate support.

Concerns

There are only a few concerns we have in regard to H.R. 1310. These relate to stipends for institutes, cost sharing or matching requirements, and the $50 million for NSF postsecondary and graduate support.

Stipends

Stipends were an integral part of the very successful summer and academic-year institute programs of the 60's. It is extremely important that stipends be a part of this program. We would suggest that stipends be set at $250 per week or $50 per day, and that they be available only for periods for which teachers are otherwise unpaid. (This should not be construed to restrict payment to teachers who have their nine-month pay spread over twelve monthly checks.) Without stipends, teachers, being among the lowest paid in our economy, will be forced to work in the summer and will not be able to participate in the institutes.

Cost Sharing and Matching Requirements

Even though we agree that the private sector has a responsibility to help support science education, we are strongly opposed to straight cost-sharing or matching requirements. Heavy defense-related investments in some regions and states create a "defense" source for those areas and a defense siphon for others. North Carolina, Texas, California, and Arizona may easily find matching funds. What about local schools asking for matching funds from General Motors or Ford in Michigan, the Steel Range of Minnesota, or Bethlehem Steel in Pennsylvania? Cost-sharing and matching requirements make the rich richer, often through defense subsidies from taxes paid out by poorer areas.

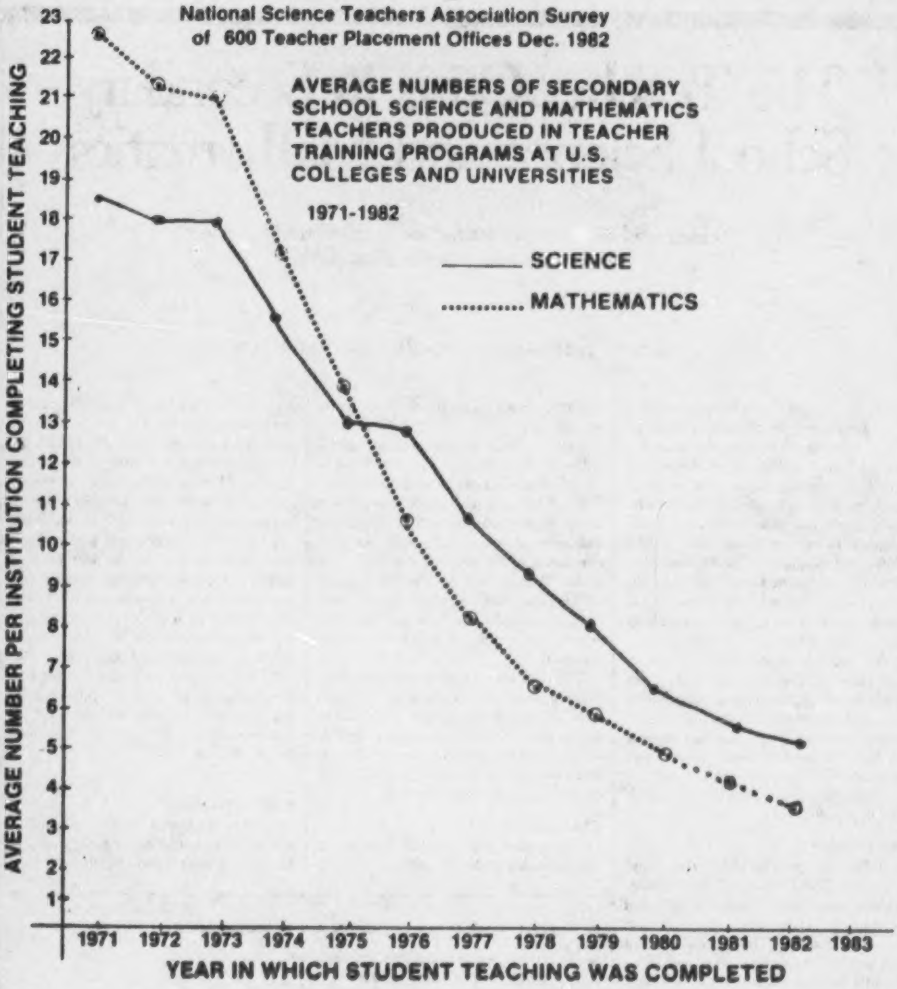
A $50 Million Bonus for NSF Research

The $50 million of unspecified postsecondary and graduate support for NSF should be changed. Since the Administration is already proposing an enormous 18 percent increase for the Research components of the NSF budget, a $50 million addition, to bring that increase to 23 percent, would be excessive. We recommend that this

$50 million be used for additional precollege support where the crisis is well documented plus some support to improve undergraduate courses and laboratories.

Recommendations

We strongly recommend that this Committee, in concert with the full Labor and Human Resources Committee, prepare a companion Bill to H.R. 1310 and move it onto a fast track for Senate action as soon as possible. With quick action, the National Science Foundation and Department of Education can begin program planning immediately so that these important initiatives can be in-place when the 1984 budget year begins.



National Science Teachers Association Survey
of 600 Teacher Placement Offices Dec. 1982

AVERAGE NUMBERS OF SECONDARY SCHOOL SCIENCE AND MATHEMATICS TEACHERS PRODUCED IN TEACHER TRAINING PROGRAMS AT U.S. COLLEGES AND UNIVERSITIES

1971-1982

The Teacher Crisis in Secondary School Science and Mathematics

Science and mathematics instruction is deteriorating as fewer teachers pursue careers in these fields.

JAMES A. SHYMANSKY AND BILL G. ALDRIDGE

Our nation faces unprecedented problems in science and engineering education, the most severe of which is the critical shortage of qualified science and mathematics teachers at the secondary level. The problem is not new. Studies by the National Education Association (1981), Howe and Gerlovich (1982), and Akin (1980) have carried this message for several years. Yet school goes on. Is the problem not as severe as the data suggest, or worse than we realize?

We recently conducted surveys of secondary school science and math teachers, secondary school administrators, and placement directors at colleges and universities to get another reading on the science and math supply and demand. The results of our surveys and the highlights from some previous studies are reported here.

The Demand

In 1980 and again in 1981, Howe and Gerlovich (1982) surveyed the 50 state science supervisors to assess supply and demand for secondary school science and math teachers. Using a scale of 1 (a surplus) to 5 (a critical shortage), they found a shortage of physics (4.15), math (3.71), and chemistry (3.96) teachers in 1980. Shortages in physics and math became more severe in 1981 (physics, 4.45; math, 4.28). Moreover, the shortages are nationwide. Only two state supervisors reported an adequate supply of math teachers; four reported an adequate supply of science teachers; six reported an adequate supply of chemistry teachers.

Akin's (1980) findings are consistent with the Howe/Gerlovich report. In a survey of teacher placement directors in 1981, Akin reported math and physics as the highest and second highest areas of teacher demand. Chemistry teacher demand was 7th and earth science 11th of the 38 areas ranked. The NEA report (1981) also ranked mathematics and natural and physical sciences as areas where the supply of teachers is least adequate.

The data from these sources are convincing but not compelling because, after all, science and math continue to be taught. In order to provide further insight into the problem, we conducted three surveys in December 1981. Our results are quite revealing.

The Supply

We surveyed 450 teacher placement offices nationwide to obtain ten-year data on the number of teachers receiving certification in a science or math area and the number accepting teaching positions. Figures 1 and 2 show the number of persons available for placement and the number accepting teaching positions in math and science from 1971 to 1980. Clearly these graphs show the serious decline in the numbers of persons pursuing teaching degrees (79 percent decline in math and a 64 percent decline in science) and an equally serious decline in rate at which those prepared accept teaching jobs. The 1981 NEA report indicates a comparable decline in persons accepting teaching positions to persons prepared as teachers across all teaching fields between 1962 and 1979.

Who Is Teaching?

We also surveyed 1,000 secondary school administrators to find out who teaches science and math at their

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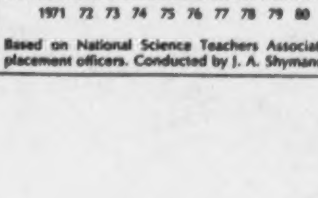
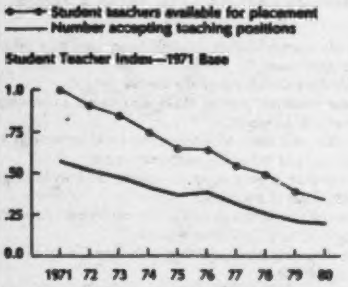
Figure 1. Student Teacher Supply Index: Math—Based on 1971 Supply.



Based on National Science Teachers Association survey of college and university placement officers. Conducted by J. A. Shymansky, The University of Iowa, 1982.

Figure 2. Student Teacher Supply Index: Science Based on 1971 Supply.



Based on National Science Teachers Association survey of college and university placement officers. Conducted by J. A. Shymansky, The University of Iowa, 1982.

schools, how many were retiring, how many were leaving for other jobs, and how many were hired recently. Administrators reported that 91 percent of their science and math teachers were teaching those classes exclusively in 1981–82—a drop from 93 percent in 1980–81. They also reported about a 1 percent rate of retirement in the science and math teaching staff and a 4 percent exodus to nonteaching jobs. Taken alone, these figures are not earthshaking. But data on replacements for the retirees and the job-jumpers are shocking. Nationwide, *half* of all newly-employed science and math teachers for the school year 1981–82 were unqualified to teach science or math. These teachers were reported hired on an "emergency basis." Figure 3 shows, by region, the percentages of emergency science and math teachers hired for the 1981–82 school year; the numbers are staggering but not surprising when viewed in terms of Figures 1 and 2. There simply aren't enough new teachers to replace those leaving or retiring.

What the Teachers Report

More than 450 teachers responded to a third questionnaire aimed at finding out about their preparation, their assignments, and their plans. From the survey we know that 60 percent of the science teachers report cuts in their budgets for supplies and equipment. These cuts are occurring at a time when school labs are already obsolete and teacher morale is low. We also learned that 79 percent of these teachers have not completed a ten-hour course or workshop in over ten years; 69 percent have never attended a computer workshop. Finally, 40 percent reported never attending an inservice course or workshop since they began teaching—an average of 16 years!

When asked about their plans for the next five years, a startling 24 percent indicated they plan to seek employment outside of education. Assuming only 4 percent actually leave the classroom for nonteaching jobs (as the administrator data suggests) and assuming the graphs showing the new entries into science and math teaching level out, the forecast for secondary school science and math is still gloomy. The mean age of the science and math teaching population is 41. As that mean moves up so will the number of retirees and the number of teaching vacancies. Demographic studies predict a leveling off of school-age populations and even a slight increase in the 80s. When these data are mixed together, it is clear that the number of emergency teachers will go up also—and that the quality of math and science instruction will go down.

Summary

Recent independent surveys all show a severe shortage of qualified secondary school science and math teachers. There has been a catastrophic decline in the number of persons preparing to teach science and math and, of those prepared, less than half take teaching positions. Secondary schools are forced to hire unqualified persons. In addition, as the mean age of the science/math teaching force rises and more experienced teachers seek employment in nonteaching jobs, the quality of instruction in our secondary school science and math classrooms will deteriorate further. We cannot afford to wait for the normal laws of supply and demand to correct the problems. A generation of school-aged children is far too precious a commodity. EL

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Figure 3. Percentage of Emergency Science and Math Teachers Hired in 1981–82.

Census Region	Percentage of Emergency Teachers Hired
Pacific States	84%
Mountain States	23%
West North Central States	43%
West South Central States	63%
East North Central States	46%
East South Central States	40%
North East States	9%
Atlantic States	43%
South Atlantic States	50%
Nationwide	50%

An NSTA Position Statement

Science-Technology-Society: Science Education for the 1980s

Preamble

Science and technology influence every aspect of our lives. They are central to our welfare as individuals and to the welfare of our society. All around us are examples of the importance of science and technology for production of food, shelter, clothing, medicines, transportation, and various sources of energy. There are an increasing number of science- and technology-related societal problems as well as increasing societal benefits. Science and technology are central to our personal and cultural welfare *and* to many societal problems. We must insure appropriate science education for all citizens.

However, the quantity and quality of science education for all people are not commensurate with the status of science and technology in society. When one would expect budgets, time spent on science-related subjects, and support for science education to be increasing, they are decreasing. At the same time these factors are declining, societal problems continue to require an understanding of science and technology. The burden of response rests heavily upon the shoulders of *all* persons associated with science endeavors—scientists, engineers, classroom teachers, other educators, and school administrators. Many of the problems we face today can be solved only by persons educated in the ideas and processes of science and technology. A scientific literacy is *basic* for living, working, and decision making in the 1980s and beyond.

There is a crisis in science education. The following science-technology-society problems demand immediate attention:

- understanding of science and technology are central to our personal and national welfare, yet public appreciation of science education has declined;
- increasing number of individual and societal problems which have an impact on the quality of life are related to science-generated technology;
- as the impact of science and technology on society has increased, the support for science education has decreased;
- compared to its recent past the United States has fallen behind in the production of scientific and technological goods and services; and
- women, minorities, and handicapped persons are under-represented in nearly all professional and technical roles in science and technology.

Declaration

The goal of science education during the 1980s is to develop scientifically literate individuals who understand how science, technology, and society influence one another and who are able to use this knowledge in their everyday decision-making. The scientifically literate person has a substantial knowledge base of facts, concepts, conceptual networks, and process skills which enable the individual to continue to learn and think logically. This individual both appreciates the value of science and technology in society and understands their limitations.

The attributes listed below help to describe a scientifically literate person. Each attribute should be thought of as describing a continuum along which the individual may progress. The progress of the individual's science education should be equated with progress along this continuum.

The scientifically and technologically literate person:

- uses science concepts, process skills, and values in making responsible everyday decisions;
- understands how society influences science and technology as well as how science and technology influence society;
- understands that society controls science and technology through the allocation of resources;
- recognizes the limitations as well as the usefulness of science and technology in advancing human welfare;
- knows the major concepts, hypotheses, and theories of science and is able to use them;
- appreciates science and technology for the intellectual stimulus they provide;
- understands that the generation of scientific knowledge depends upon the inquiry process and upon conceptual theories;
- distinguishes between scientific evidence and personal opinion;
- recognizes the origin of science and understands that scientific knowledge is tentative, and subject to change as evidence accumulates;
- understands the applications of technology and the decisions entailed in the use of technology;
- has sufficient knowledge and experience to appreciate the worthiness of research and technological development;
- has a richer and more exciting view of the world as the result of science education; and
- knows reliable sources of scientific and technological information and uses these sources in the process of decision making.

Recommendations for K-12 Grade Levels

Elementary School Science

Science should be an integral part of the elementary school program. It should be used to integrate, reinforce, and enhance the other basic curricular areas so as to make learning more meaningful for children.

A carefully planned and articulated elementary science curriculum should provide daily opportunities for the sequential development of basic physical and life science concepts, along with the development of science process and inquiry skills.

Elementary science should provide opportunities for nurturing children's natural curiosity. This helps them to develop confidence to question and seek answers based upon evidence and independent thinking. Children should be given an opportunity to explore and investigate their world using a hands-on approach, with instructional materials readily available.

The focus of the elementary science program should be on fostering in children an understanding of, an interest in, and an appreciation of the world in which they live.

Middle/Junior High School Science

The middle/junior high school science curriculum should be designed to accommodate the needs and learning styles of the early adolescent. Students should be provided with daily opportunities to explore science through reading, discussion, and direct learning experiences in the classroom, laboratory, and field.

Middle/junior high school science should contribute to the development of scientifically literate persons and not simply prepare them for the next science course. National studies have shown that often middle/junior high school science is designed to prepare students for high school biology with no emphasis on physical science. In addition, studies show that fewer than one half of the junior high students going on to high school take chemistry and physics. Therefore, it is imperative that an important thrust of middle/junior high school science be toward the physical and earth sciences.

Middle/junior high school students should continue to develop science process skills and content. Middle/junior high school science should emphasize the *application* of both skills and content to the students' personal life situations and enable students to begin examining societal issues that have a scientific and technological basis. Middle/junior high school students need to *apply* what they have learned soon after their instruction to insure the lasting value of the experience.

High School Science

The high school science curriculum should enable students to further develop their scientific and technological literacy. Courses incorporating well-designed laboratory and field work help to meet this need.

A balanced core of two years of science should be required of *all* students, consisting of one year of life science and one year of physical science—both taught in a science-technology-society context. The courses should provide students with opportunities to develop skills in identifying science-based societal problems and in making decisions about their resolution.

Students interested in exploring or preparing for careers in science, engineering, or technical fields should have the opportunity to take additional discipline-based courses in advanced biology, chemistry, physics, and earth sciences. These courses should be planned and sequenced to take advantage of the students' increasing command of mathematics.

Time on science learning

- Lower elementary level (grades K-3): a minimum of 1½ hours/week of science should be required.
- Upper elementary level (grades 4-6): a minimum of 2½ hours/week of science should be required.
- Middle/junior high school level (grades 7-9): a minimum of 1 hour/day for at least 2 full years of science should be required of all students.
- Senior high school level (grades 10-12): a minimum of 1 hour per day for 2 full years of science should be required. The courses should represent a balance of physical and life sciences.

Emphasis on programs for all students

- In elementary, middle, junior high, and senior high school grades, science education programs should provide basic concepts for all students. Opportunities should be available for students with diverse interests and commitments, including students with exceptional interests and talents in science.

Emphasis on science education for the adult general population

- Schools should provide educational opportunities in science for all the adult population in their community.
- Colleges, universities, and national organizations should increase emphasis on science education for adults through public lectures and seminars.
- The important contributions of out-of-school education programs such as museums, TV, planetariums, and zoos, should be recognized and utilized by all those involved.

Emphasis on the professional development of science teachers through inservice opportunities

- Colleges, universities, and other agencies should develop teacher education and inservice education programs that are consistent with this policy statement.
- School districts should provide opportunities, encouragement, and recognition for teachers who maintain a high level of professional competence.

Emphasis of laboratory and field activities

- Elementary level laboratory and field activities should stress the development of basic inquiry skills.
- Middle/junior high school level laboratory and field activities should stress the application and extension of inquiry skills as a means of obtaining knowledge and resolving problems.
- High school level laboratory and field activities should emphasize not only the acquisition of knowledge, but also problem solving and decision making.

Science instruction matches students' cognitive, physical, social, and emotional development

- Schools should provide objectives, content, and instructional strategies that are appropriate to the student's stage of mental, moral, and physical development.
- Varying strategies and materials should be provided at all grades to accommodate students with various levels of learning skills and mental development.

Emphasis on science-related societal issues

- Elementary level: a minimum of 5 percent of science instruction should be directed toward science-related societal issues.
- Middle/junior high school level: a minimum of 15 percent of science instruction should be directed toward science-related societal issues.
- Senior high school level: a minimum of 20 percent of science instruction should be directed toward science-related societal issues.

This NSTA Position Statement was adopted unanimously by the Board of Directors in 1982. Additional copies of this position statement are available; write to the National Science Teachers Association, 1742 Connecticut Ave., N.W., Washington D.C. 20009.

The Committee to Develop the NSTA Position Statement
SCIENCE-TECHNOLOGY-SOCIETY:
SCIENCE EDUCATION FOR THE 1980s

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Senator **Stafford**. Thank you very much, Mr. Aldridge. We are 5 minutes into the vote that is over on the floor, so the Chair is going to have to, with reluctance, temporarily recess the hearing. We will start with you, Dr. Willoughby, as soon as I can get back here.

[Whereupon, a brief recess was taken.]

Senator **Stafford**. The subcommittee will please come to order.

Dr. Willoughby, Senator Weicker has especially asked me to welcome you in his name, as well as that of the subcommittee. In addition to the vote which we both just ran to, Senator Weicker is chairing a hearing for the Subcommittee on Energy Conservation.

He would say if he were here that Dr. Willoughby is president of the National Council of Teachers of Mathematics. Dr. Willoughby received his AB and his MAT from Harvard University, and his doctorate of education from Columbia University.

Doctor, you are currently the director of math education and professor of mathematics at New York University, and you are the author of a number of professional works, including the elementary school math text, Real Math.

For the subcommittee and for Senator Weicker, I welcome you to the subcommittee and we would be glad to hear your testimony.

Dr. **Willoughby**. Thank you, Mr. Chairman.

Senator **Stafford**. You have to pull that mike up a little. Those are not very good ones and you need to speak almost right into them.

Dr. **Willoughby**. Thank you. One of the problems about testifying before this committee is these are the good guys who are already converted, and what we really ought to be talking to is the people who do not fully understand the problem.

The problem has been delineated very nicely by several people already. The demands of an increasingly technological society for a quantitatively literate population are great and are growing.

Solutions to the problem have been proposed by various different groups, and most of them are very minor solutions, very inexpensive solutions, and will not work. One of the difficulties is that if you, in fact, retrain teachers or prepare new people to become teachers of mathematics or the quantitative sciences—physics, mathematics and chemistry—what you will do is also prepare them for jobs in industry, which pays them approximately twice as much and which gives them much, much better working conditions. Therefore, a large number of these people will promptly leave the teaching profession and go into industry.

It seems to me that one of the problems that has bothered a lot of people is the question of whether or not the Federal Government ought to be interested in education. According to the Constitution, the Congress is responsible for the common defense and general welfare of the United States. There is nothing that is more important to the long-term common defense and general welfare of the United States than the education of our children today, and we must at this point begin to invest the kind of money and the kind of time in education that is necessary to protect our defense and our economy in the future.

Some of the short-range solutions that have been proposed and some of the bills before Congress come up with such remarkable sums as $400 million, which seems a great deal to me since I have been a teacher all of my life, but is, in fact, less than six-hundredths of one percent of the entire Federal budget.

Senator **Stafford**. Doctor, let me just interpose that it also is eight times as much as this administration has proposed to be spent on this subject.

Dr. **Willoughby**. I am very conscious of that, and the comments I am making I would prefer to be heard by the administration than by the people who have proposed the $400 million.

Some of the short-term solutions have scholarships of relatively small amounts of money; summer institutes and other procedures to increase the number of mathematics and science teachers. These, in general, are not going to have very much effect as long as we do not do something about the conditions that exist in the schools.

Differential salaries for teachers in shortage subjects will, for the most part, do nothing more than reallocate the teachers that are available. As one State increases the salaries for mathematics and science teachers, that State will attract teachers from other States.

If the difference is of the magnitude of $10,000 or more, then we may attract people out of industry into the school system if we can also, at the same time, substantially improve the conditions within the school.

Something that has not been mentioned today, as far as I have heard, is that many teachers are seriously in fear for their lives when they go to school. You should get combat pay for going into many of the schools that teachers are trying to teach in. It is amazing how many good, excellent teachers we still have in mathematics and science in the schools today.

It is amazing that, in fact, our best students are better than those from most other countries and are getting, in fact, a better education. This will not continue to be the case unless we do something drastic in the immediate future.

Rather than asking how we are going to pay for the education of our children, it seems to me that what we must do is reorder our priorities and put the education of our children first, since that will, in the long run, drastically reduce the amount of money spent for jobs bills, for jails, for welfare, for retraining citizens to function effectively in our society, and will ultimately produce a much stronger defense establishment for less money.

We need citizens and leaders who have the vision of a better future and who are willing to commit sufficient resources now to the realization of that vision. If a true commitment were to be made to the education of our youth, I would propose the following four steps: first of all, improve the conditions within the schools to make them more attractive and efficient places to teach; make them as attractive as industry is to teach in; make it a nice environment; make it at least an environment in which the teacher does not have to worry about whether he or she is going to be attacked during the day by somebody, either a student or somebody off the street.

I would recommend increasing the length of the school day and the length of the school year so that we get more education and possibly better education. I would strongly recommend that we improve the standards for becoming a teacher and for remaining a teacher.

As of now, we have large numbers of incompetent people teaching mathematics and science who are not even certified in many cases. I know of one instance in New York State where a teacher failed 10th grade geometry on five separate occasions, never passed it, and is certified not only to teach 10th grade geometry, but the courses that come after that course, 11th grade algebra and trigonometry, without ever having passed a course more advanced than 10th grade geometry.

Finally, and this is all a package and one part will not work without the other, it is essential that we pay a living wage to teachers. I believe that we should double the salary of every teacher in the Nation, and that a major portion of the funds for that doubling should come from the Federal Government. Unless we do something of that sort, these other minor moves that we are making will have had relatively little effect in the long run.

There is a crisis in education today that will profoundly affect the future of the Nation. If we act by doing just a little, we may fool ourselves into believing that we have solved the problem when we have, in fact, only put it out of our minds. Too little action may be worse than no action at all. Thank you.

[The prepared statement of Dr. Willoughby follows:]

THE CRISES IN MATHEMATICS EDUCATION

Testimony Before the Committee on Labor and Human Resources

Sub-Committee on Education, Arts, and Humanities of the United States Senate

By, Stephen S. Willoughby
President, National Council
of Teachers of Mathematics

Demands of an increasingly technological society for a quantitatively literate population are great and growing. The main roadblock to providing mathematically competent future citizens is an insufficient number and decreasing supply of qualified teachers of mathematics. "The common defense and general welfare of the United States" require a significant national commitment to education.

According to one survey at the University of California, 92% of the women and 43% of the men in the freshman class had already disqualified themselves from three-quarters of the possible majors for lack of sufficient mathematics. A 1982 survey by the Center for Public Resources found that according to business representatives mathematics and science skills are below what are needed even in the less advanced jobs and in secretarial and supervisory positions.

Facts of this sort have already influenced state and local education authorities to increase the requirements in mathematics, science, and computer science. Colleges and universities are raising their standards in mathematics and science for entry. But even without such requirements, high school students have begun to take more mathematics, science, and computer science because they correctly perceive these as the skills that will be needed in the world of the future. For the foreseeable future there will be a greater demand for, than supply of, people who can and will think quantitatively and make intelligent decisions regarding real-world situations involving number and space. The problem is serious, but the young people of the nation, with and without guidance from their elders, are beginning to rise to the challenge.

Another problem that has been critical is rapidly becoming more critical as school students take more mathematics and computer science. With the exception of one or two years (1969-1970) there has been a documented shortage of qualified mathematics teachers for the past 40 years in this country. The shortage is rapidly getting worse. Some of the reasons include:

1) There has been a 77% decline in the number of secondary-level mathematics teachers prepared in the past ten years, and only about 55% of those prepared to teach mathematics actually enter the teaching profession. In Missouri, for example, the number of college graduates who could have been certified to teach mathematics from the class of 1973 was 443. In 1981 the figure was 95. In 1982 it was 57.

2) Almost five time more mathematics and science teachers left the profession for nonteaching jobs than left for retirement in 1980, and the demands of industry and government for more mathematically trained individuals are increasing.

3) The demands for computer courses in schools are being met primarily through the efforts of mathematics teachers who are then available to teach fewer mathematics courses.

4) The supply of competent women who were willing to work as underpaid and undervalued teachers has been reduced as society has begun to correct the historical inequities in professional opportunities for women and men.

Perhaps the most surprising fact about the situation is that there are so many dedicated, well-qualified teachers still teaching in this country. Teaching is certainly the most important and difficult profession known to the human race. Our destiny is dependent upon the minds of our future citizens. The human mind is the most complex and remarkable thing on the face of the earth — by comparison the most advanced computers look like oversized Tinkertoys. Yet, we have entrusted those minds to the members of one of our most underpaid, overworked, and undervalued professions. It is amazing that anybody who is competent to do the job is willing to do it. Somebody once remarked, correctly, that any competent teacher who continues to teach is truly committed — or truly ought to be.

In spite of the fact that there are many dedicated, competent teachers in the schools of the nation, there are not nearly enough — especially in the areas of mathematics and the physical sciences (physics and chemistry). Although there appear to be live bodies in front of most mathematics classrooms in the country, those who are teaching are often grossly underprepared. Last year 50.2% of the newly hired science and mathematics teachers were judged unqualified by the principels who hired them. And, a principal ordinarily considers a teacher qualified if the teacher meets state certification requirements. In many states, a reasonably imaginative prospective teacher can be certified to teach mathematics with far less than adequate preparation. For example, I know one young man who received certification to teach mathematics in New York even though he had failed the Regents' Examination in tenth-grade geometry on five separate occasions and had never passed either geometry or any more advanced mathematics course.

The lack of enough qualified mathematics teachers is unfortunate for the many students who will have to learn mathematics without adequate instruction. If they fail to learn, understand, and appreciate mathematics, it will forever prevent them from understanding and dealing with the world as well as they might have. Beyond that, their options for pursuing future education and for fulfilling their occupational goals will be severely limited. Because of the needs of individuals, local and state school authorities have an obligation to do everything in their power to provide adequate teachers and an adequate education for all children in every school in their jurisdictions. Unfortunately, local voters are aware of the great mobility of the modern American family (40 million Americans — almost one-fifth of the population — move every year), so they are often unwilling to provide the tax revenues with which to give a quality education to a child who will probably become a citizen of, and be employed in, another community. Thus, what was once a local responsibility for education ought now to be shared by the federal government.

Beyond the natural interest of each individual in acquiring an adequate education the nation has a vested interest in the education of every citizen.

- The rights and duties of citizenship require an educated citizenry, and in an increasingly technological society, that education must include mathematical and scientific reasoning.
- If the future problems of the nation and the world are to be solved, they will be solved by citizens and scientists with a better mathematical education than is commonly available today.
- The economic future of each nation is becoming more dependent upon the mathematical and scientific education of its citizens — a fact that has been recognized and acted upon by our major economic competitors.
- Finally, the very defense of the nation is now dependent upon the education of our citizens. Two hundred years ago when the nation was defended with musket and cannon, and armies traveled on foot or horseback a higher education was of little need to the defenders of our country. Today we find that army recruits do not know enough mathematics to understand the manuals written to help them run the sophisticated military equipment on which the nation is investing so much.

Congress has the power and obligation to "provide for the common defense and general welfare of the United States." Today, that power and that obligation require Congress to act to assure the adequate education of the children of the United States.

Many short-term solutions to the crisis in mathematics and science education have been proposed, and some are being tried by state and local education officials. These include salary differentials based on shortage, loans for prospective teachers in shortage areas with forgiveness of parts of the loans for each year of teaching, improved conditions (increased planning time, reduced nonprofessional work such as supervising study halls and lunch rooms, more support for attendance at professional meetings and for graduate work, etc.), and encouraging industries to hire mathematics and science teachers during the summer to enhance their incomes and their knowledge of how their subjects are used in industry. If sufficient resources were poured into solutions of this sort, there would certainly be an effect. Insofar as salary supplements are offered by one state or locality, those supplements are likely to produce a reallocation of mathematics and science teachers but will probably not substantially increase the number of such teachers in the nation as a whole unless the supplements are of the order of magnitude of $10,000 per year or more, since that is what would be required to compete with salaries offered to the same people in industry. The problem with such additional support for teachers of shortage subjects is the pernicious notion that might be fostered that those teachers are somehow better or more important than the teachers of other subjects — the only justification for such supplements would, of course, be the law of supply and demand.

Another short term "solution" to the problem that holds little promise of success is recertifying teachers of other subjects to teach mathematics and science. This practice tends to lower standards. Teachers whose livelihood depends upon their changing subjects usually meet the absolute minimum state requirements for certification, are often not interested in the subject to which they were forced to switch, and may be expected to simply bide their time until they have enough seniority to go back to teaching the subject that was their first love.

If we are to solve the long-term crisis facing the nation in education, the Congress and the President must take seriously the charge to "provide for the common defense and general welfare of the United States." And, they must realize that the long-range defense and general welfare of the nation are more dependent on the education of our youth than on development or deployment of particular technological innovations. With a federal budget in excess of 700 billion dollars, there has to be room for a few billion dollars to improve the education of our children and thus insure the future defense and economic welfare of the nation.

If a true national commitment were to be made to education, I would propose that the following four steps be taken:

1) Improve conditions within the schools. Make clear to our educators what they are supposed to be achieving and what they are not responsible for doing. Stop insisting that teachers supervise the cafeteria, the hall, the parking lot, and so on. Can you imagine the reaction if physicians were required to supervise the hospital parking lot? Provide strong support for maintaining discipline within the classrooms so education can proceed. Provide better educational materials and better opportunities and support for teachers to evaluate those materials and use them effectively. Provide better equipment and other facilities. Provide more opportunity and incentive for teachers to continue their professional development through participation in activities of professional societies and through further formal education. Beyond this, students, parents, and other citizens should openly show excellent teachers the respect to which they are entitled for doing a difficult job well — and many of our present teachers ARE doing the job magnificently.

2) Increase the school year to at least 220 days. The education lost during the summer is far greater than the simple lack of having learned for 40 or so additional days. Any teacher can tell you that students forget a great deal over the summer, and much of the first month back is spent relearning that which has been forgotten.

3) Improve standards for becoming and remaining a teacher. Professional organizations such as the National Council of Teachers of Mathematics have published standards for becoming teachers. These standards, by any reasonable criteria, are minimal given the job the teacher is expected to accomplish. However, state certification requirements are invariably lower than the standards advocated by the profession, and many states have tended to lower those standards still further in light of shortages. But, beyond the need for higher entry standards, we must realize that the world is changing and teachers must change with it or be unable to provide students with an up-to-

date, appropriate education. A teacher who is certified today at the age of 22 could still be teaching in the year 2031. Although the world will certainly have changed by then, most states do not require the teacher to have learned anything new in that time.

4) Double the salary of every teacher in the country. Double the salaries of those in shortage areas and in nonshortage areas, of those who are good and those who are not so good. Does this mean that some incompetent teachers will be overpaid? Of course. But any teacher who is incompetent is already overpaid. Changes proposed here would greatly improve the quantity and quality of people trying to become teachers and would improve the procedures used to select and educate those people, as well as making it possible for the many fine teachers who are already teaching to concentrate more effort on improving their teaching still further. Without such dramatic action, this nation can expect to gradually lose its predominent place in the intellectual, technological, economic, and creative activities of the world. Because the general welfare of the nation is at stake, the Congress has both the power and the obligation to act. The financial support for this improvement should probably come largely from the federal government, so that when federal funds are matched by local and state governments, the federal government would be paying about one-third of the cost of faculty salaries in schools.

There is a crisis in education today that will profoundly affect the future of the nation. If we act by doing just a little, we may fool ourselves into believing that we have solved the problem when we have in fact only put it out of our minds. Too little action may be worse than no action at all.

Senator STAFFORD. Thank you very much indeed, Dr. Willoughby.

The Chair is beginning to feel a little bit frustrated by the fact that another rollcall is in progress, which I did not anticipate. Dr. Leeson, I guess it would be best if, with deep regret, I recess here once again long enough to again go over and vote, rather than have you testifying with no member of the committee here to hear you.

So, we will again, with reluctance, have to recess the committee long enough for its chairman to go and vote.

[Whereupon, a brief recess was taken.]

Senator STAFFORD. The committee will please come to order. At the time the second rollcall caught up with us, we were about to hear Dr. Leeson. Without further ado, Doctor, we would be delighted to receive your testimony.

Dr. LEESON. Thank you very much, Mr. Chairman, Senator Pell. I sit before you a product of the NSF fellowships of two decades ago, and I commend that path as one that would be interesting.

I would like, with reference to the parable of the blind man and the elephant, to provide you with an industry viewpoint of certain portions of the problem under discussion. I represent the American Electronics Association, an association of 2,000 electronics manufacturers with over a million employees.

As I am sure you are aware, electronics and information technologies are major contributors by creating jobs and by creating productivity in other sectors. By the end of the century, it is expected that electronic and information technology will be the second largest industry in the United States.

The area I would like to focus on today is the upper level of the academic spectrum. Industry requires, in order to carry out its mandate in international competition, both military and economic, a reliable supply of brain power. I am wanting to focus today on the leveraged individuals—those individuals such as faculty and creative technologists who themselves create many additional jobs, sometimes in many cases 20 to 50 other jobs, through their own efforts.

In absolute terms, as I am sure you are aware—and there is written testimony with data—by comparison both to our trading partners and our military competitors, the United States is not doing well in the generation of technology creators.

The view of our members is that there is a bottleneck at the very top of the educational chain which is impacting the entire chain. We have data which suggests that, today, two out of every three qualified and acceptable applicants to colleges of engineering are turned away and lost to society as a result of the lack of facilities and faculty at those colleges.

I believe very strongly that if we can resolve some of those problems, that will create a vacuum on the rest of the system which will benefit the entire society. This is due to a shortage of two elements; one is faculty and the other instructional equipment.

The faculty shortage is, I believe, in large part due to the low salaries relative to industry and to inadequate teaching laboratories. Many faculty who would otherwise stay in school to teach do not find the equipment adequate to perform the job.

[Whereupon, Senator Pell resumed the Chair.]

Dr. **Leeson**. I think that it is important to ask two questions, then. What should the public response be and what should the private sector response be?

AEA has responded by creating from among its members the Electronic Engineering Foundation. EEF is committed to creating 500 faculty grants for salary assistance and graduate fellowships. These are all incentivized toward preserving the individuals who receive these in teaching. They are returnable to AEA if the individuals leave teaching within a specific period.

A number of companies have banded together in various efforts and industry has contributed a major element to advanced education. We can identify some 200 to 300 million of industry contributions that specifically aid the creation of technology creators, and I am speaking today specifically with reference to the education of those folks who will create the technology that the rest of us will use, as opposed to the also very important issue of educating the general public in technical literacy and the equally important issue of retraining those folks who have been displaced by the advances in technology in the economy.

I know of no way to slow the advance of technology; if we do not do it, our trading partners will. I think that it remains then to ask what is an appropriate Federal response. From the industry viewpoint, we would benefit greatly from additional Federal incentives by way of tax incentives, permitting industries to contribute even further.

I believe that we also feel very strongly that the problems at the very top of the academic chain, if resolved, can provide a tremendous incentive, raising the level of the entire rest of the academic area.

We would like to see leveraged action, particularly by way of tax issues. Companies are currently incentivized by way of the 1981 Tax Act to contribute equipment to universities for research purposes but not for teaching purposes.

Furthermore, many universities cannot accept even the equipment which is offered because there is no tax incentive for the accompanying service contracts, and the universities are not themselves able to provide the maintenance of equipment which is offered to them.

We would like to see the R&D tax credit extended beyond 1985, specifically with reference to educational impact. We would like to see the expansion to incentivize the donation of equipment, particularly instructional equipment, to community colleges, which are currently excluded, as well as 4-year institutions.

We certainly would suggest a resumption of support of faculty fellowships, with an incentive provided to those individuals who will stay with teaching.

The industry appreciates the opportunity to address you, and as you develop legislation, we would certainly hope to participate. Thank you.

[The prepared statement of Dr. Leeson follows:]

Statement of David B. Leeson

for the American Electronics Association

Before the Subcommittee on Education, Arts, and Humanities
Committee on Labor and Human Resources
United States Senate

March 8, 1983

Summary

- The U.S. electronics industry is experiencing a growing shortage of the specific skills needed to maintain and expand our position in the world economy.
- The magnitude of the problem continues to increase.
- The most serious current problem restricting the increase in electrical and computer science engineering graduates - those specialties of highest need to electronics - is the shortage of faculty and instructional equipment in undergraduate programs.
- AEA has established the Electronics Education Foundation to encourage and aid contributions by member companies to engineering universities.
- The federal government can help significantly by enacting tax policies which encourage additional private sector action.

AEA **American Electronics Association**
1612 K Street, N.W., Washington, D.C. 20006

Statement of David B. Leeson
for the American Electronics Association
Before the Subcommittee on Education, Arts, and Humanities
Committee on Labor and Human Resources United States Senate
March 8, 1983

Mr. Chairman and Members of this Distinguished Committee:

My name is David Leeson. I am the founding president of California Microwave, Inc., a manufacturer of telecommunications and defense electronics equipment. The company was founded 15 years ago and employs approximately 1,200 people.
I was educated at Caltech, M.I.T. and Stanford, and a substantial portion of my graduate education was supported by federal and industry fellowships. I received my Ph.D. degree in 1962.

I am a member of the Board of Directors of the American Electronics Association (AEA) and am appearing before you today on behalf of that organization. The American Electronics Association represents over 2,000 growing high technology companies throughout the U.S. The Association's membership includes all segments of the U.S. electronics industry, including computers, telecommunications, defense, instruments, semiconductors, software, research, and office systems. While the Association numbers among its members many of the largest electronic manufacturers, a majority of AEA's member companies are relatively young innovative organizations employing fewer than 500 employees. In aggregate, AEA companies employ over 1,000,000 Americans.

The electronics and information technology companies are major contributors to the industrial development of the United States, both through the creation of jobs within the industry and through the improvement of the productivity of all other sectors of the economy. These same technology companies are also key resources in the national defense. The industry has had a phenomenal growth rate of 17% over the last decade, and currently ranks ninth among U.S. industry categories. By the end of the century electronics and information technology industries are expected to rank second.

Sales of the top 100 electronics companies increased 46% between 1979 and 1981; this is reflected in the creation of a substantial number of U.S. jobs within the industry. Additionally, the electronics and information technology sector is a bright spot in the continuing creation of innovative and entrepreneurial new companies which have proven the ongoing source of economic growth in the U.S. economy.

In addition to ongoing need for capital and a favorable regulatory climate, the electronics industry requires a reliable and growing pool of brainpower and know-how. In many portions of the industry, each innovative engineer can create 25 to 50 additional jobs. It is on this leverage potential of the technology-creators--the electronic/electrical and computer engineers--that I would like to focus today.

Math, Science & Engineering Education

The first issue I would like to address is the question, "What is the industry view of the magnitude of the problem in math, science, and engineering education?" Both in absolute terms and by comparison to our trading partners and military competitors, the U.S. electronics and information technology industry is experiencing a growing shortage of the specific skills needed to maintain and expand our position in the world economy. Projections for these specific, leveraged skills show a growing problem.

As I am sure you are aware, our international competitors are far outpacing the United States in the number and proportion of electronic engineers who are graduated each year, five times the number graduated by the U.S. For every one million population, the Soviet Union annually graduates 260 electrical engineers, Japan 163, and the U.S. 67. For every 10,000 population, 70 in the U.S. and 400 in Japan are engineers. Engineering accounts for only 7% of the total undergraduate degrees awarded in the U.S., but 21% for those in Japan, 35% in the Soviet Union, and 37% in West Germany.

The magnitude of the problem continues to increase--in spite of the respite provided by the current state of the economy. A survey of its members conducted two years ago by AEA projected a shortfall between our need for additional electrical and computer science engineers and the new supply from colleges of some 20,000 annually through 1985. The Bureau of Labor Statistics estimates electrical engineering jobs will increase 150,000 by 1990.

AEA is aware of a number of related educational issues, including problems of low technology content of elementary and high school programs. In our members' view, the problem of providing a sufficient flow of electrical/electronic and computer engineering graduates constitutes a bottleneck which demands our first attention.

Engineering Faculty Shortage

In the estimation of AEA's Blue Ribbon Committee on Engineering Education, some two out of every three qualified applicants to undergraduate electrical/electronic and computer engineering programs cannot get into U.S. colleges and universities. Once turned away, these qualified resources are lost to the U.S. The most serious current problem restricting the increase in electrical and computer science engineering graduates--those specialties of highest need to electronics--is the shortage of faculty and instructional equipment in undergraduate programs.

Faced with a current 10% or some 2,000 to 2,500 engineering faculty vacancies, many colleges and universities are capping enrollments. Half of these faculty positions have been vacant for over a year. Vacancies approach 50% in some high tech specialty areas, such as solid state, digital systems, and computer engineering. This country needs 1,000 new engineering faculty each year over the next decade just to remain steady. We are producing only 450.

The engineering faculty shortage is primarily caused by two factors: low salaries and inadequate teaching laboratories. There is no incentive for a U.S. citizen with a bachelor's degree in electrical or computer engineering to get a graduate degree and teach. That same B.S. level student can go immediately from college into industry and start at an annual salary between $23,000 and $29,000. Going on for four years of costly graduate study likely brings a salary decrease if one wants to teach: at most universities, an assistant professor of engineering begins at between $19,000 and $26,000. A recent study of southwest colleges showed that engineering faculty members who left academia for industry raised their salaries $13,588 or 55 percent.

Equipment Shortages

In addition to low academic salaries, inadequate teaching laboratories make engineering professorships unattractive to U.S. citizens. It is not unusual for a college's instructional equipment to average 20 years of age or older. As the president of one Fortune 500 company remarked after touring a university engineering department, "The only time my engineers will see equipment of this type is when they tour the Smithsonian." It is estimated that--without adding programs or students--updating instructional labs will cost approximately $1 billion.

This combination of low salaries and lack of state-of-the-art equipment coupled with the high cost of graduate tuition has made it very difficult to attract U.S. citizens into graduate study in engineering.

We are concerned about quality as well as quantity. Both are suffering due to the faculty shortage. From 1980 to 1981, 31% fewer engineering programs were given normal six-year accreditation, and during the same period there was a 71% increase in those asked to "show cause" why accreditation should not be terminated.

Unless we reverse the downward trend, we face the loss of world economic and defense leadership positions.

Foreign students remain the primary source for new faculty recruitment, not displacing U.S. citizens but simply filling the graduate gap left because U.S. students do not wish to apply. The number of Ph.D./EEs granted over the past 10 years has actually decreased by 25%. In 1971, 899 Ph.D./EEs were awarded in this country. By 1981, the number had decreased to 503--half of which went to foreign nationals. The pool from which faculty come is drying up.

The second question then is, "What is the appropriate response by the private sector to remedying the problem?"

AEA's Program To Redress The Shortage

AEA began last year by forming a Blue Ribbon Committee to study and recommend a plan of action. Under the leadership of Dr. William Perry, former U.S. Undersecretary of Defense for Research and Engineering, and with guidance from members such as John Young, President of Hewlett-Packard, Robert Noyce, Vice-Chairman of Intel Corporation, Dr. Joe Pettit, President of Georgia Institute of Technology, and Dr. Richard Atkinson, formerly head of NSF and now Chancellor of the University of California at San Diego, the Association has launched an aggressive program.

AEA's Board of Directors set a goal for each member company to invest 2% of its R&D expenditures in engineering education. AEA established the Electronics Education Foundation to encourage and aid contributions by member companies to engineering universities. The Foundation's 1983 goal is to raise $10 million through its 13 industry committees around the country. It is focusing on funding 300 $10,000 faculty development grants to augment faculty positions to help universities attract and retain professors and 200 fellowship-loans to fund graduate study for U.S. citizens who wish to get a doctoral degree and teach engineering. Hewlett-Packard has just joined AEA in this effort and is funding 50 fellowships at a cost over the next six years of some $6 million. Other members to date have pledged 35 additional fellowships--and the national campaign is just beginning! Control Data in cooperation with the Foundation has just announced a $6 million program to donate microprocessors and lower division engineering courseware to some 100 colleges and universities around the country.

The National Science Foundation estimates that industry spending on universities increased almost fourfold during the past decade with an estimated $275 million going to academic laboratories in 1982. A few specific examples of the efforts of companies to redress the problem are:

- In 1982 IBM funded more than 90 fellowships in engineering, computer science, and information systems, and awarded over $750,000 in grants to departments of engineering and computer science, and it has announced it will donate $50 million to the five schools that come up with the best proposals for manufacturing engineering programs;

- General Electric Co. has increased to $10 million the money it gives annually to higher education;

- American Telephone & Telegraph Co. will award 25 four-year fellowships each year to promising science students, for an annual cost of $2 million;

- Hughes Aircraft Co. provides about $8 million a year support to colleges and universities through various programs;

- Loral Corporation has contributed $165,000 for a microwave laboratory at City College of New York;

- Motorola has given $1.2 million to Arizona State's College of Engineering and Applied Sciences to support its Center of Engineering Excellence;

- Analog Devices, Inc. has contributed $175,000 to Massachusetts' University of Lowell to fund a new engineering professorship;

- 3M Co. has given $1.2 million to two research centers at the University of Minnesota's Institute of Technology;

- National Semiconductor has donated equipment valued at $376,000 to Rochester Institute of Technology for its micro-electronics program, in addition to its regular assistance to 12 other engineering schools nationally.

The preceding examples barely scratch the surface of corporate support for scientific and technical education. Despite the monumental effort directed by industry at solving the technical manpower problem, an effective solution requires time and action on multiple levels.

An Appropriate Federal Response

This brings me to the third and last question, "What is the appropriate federal legislative response?" Industry clearly cannot do the job alone. Federal assistance is also needed. In enacting the "National Science and Technology Policy, Organization, and Priorities Act of 1976," according to a GAO report, Congress recognized the technical manpower pool of this country as an invaluable national resource. The GAO report states: National policy should include a continuous appraisal of the roles science and technology play in achieving goals and formulating policies, including the recruitment, education and training, and beneficial use of adequate numbers of scientists, engineers, and technologists.

Besides the direct funding of science, math, and engineering education through traditional channels such as NSF, the federal government can help significantly by enacting tax policies which encourage additional private sector action. Currently, the tax incentives provided for by the Economic Recovery and Tax Act of 1981 (ERTA) encourage companies to donate new equipment to colleges and universities for research purposes. If the quality and quantity of our undergraduate education is not to continue to deteriorate, however, the R&D tax credit and the equipment provisions of ERTA need to be extended beyond 1985 and also expanded to the following areas: donations of instructional equipment to both community colleges and four-year institutions, donations of used equipment not more than three years old, service contracts so that universities lacking maintenance money can cease turning down donations, faculty salary augmentation grants, and graduate student fellowships for U.S. citizens to get doctorates and teach.

The electronics industry is ready to work with this committee and other members of Congress on remedies to the engineering education problems. There are serious long-range implications for the United States if industry, education, and government do not work more vigorously to solve the situation.

I appreciate the opportunity to address you today. As you develop legislation, AEA will be pleased to participate.

Senator PELL. Dr. Rutherford, there are two questions I could ask you briefly. In your testimony, you suggest two interesting proposals to improve our Nation's capacity to teach math and science, both of which would involve a lot of our Federal resources.

In view of the deficits facing us, what would you view as the most appropriate solution in the short turn that the Federal Government can undertake to improve math and science education?

Dr. RUTHERFORD. Senator, I think in the short term you are on the right track by dealing with the problem of the preparation of the teachers as the major emphasis, as long as there is some money to provide some support for identifying talented students and encouraging them and some funds for research and development.

Those funds that the Federal Government might at this point invest are of the order that is being talked about, of some hundreds of millions, but not billions.

Many of the problems that Professor Willoughby addressed are the kinds that need to be taken care of at the State and local level, and I agree with him that if they are not done there, then the Federal investment may be wasted.

My point is, Senator, that if Congress stops with these bills which I take to be emergency measures, and does not focus on underwriting the reeducation of many of our science and math teachers, that would not get us into the future where we need to be.

Senator PELL. Thank you very much. Also, Dr. Rutherford, what has been your experience with student loan forgiveness as a means of increasing the number of math and science teachers? Do you think that loan forgiveness is a sufficient incentive for students to choose teaching careers?

Dr. **Rutherford**. I have no data on that, and I believe other people do. I can only say that while I think it is appropriate, I would not believe that by itself it would radically increase the number of science and mathematics teachers.

I think that the fundamental circumstance is the working conditions of the teachers, and no matter what they are paid or what incentives for fellowships there may be, unless and until they are able to be in circumstances in which they can successfully teach their subject—have the resources, have the support system, and have the respect of the community—then the rest is not going to work.

Senator **Pell**. I thank you, and I thank all of you very much indeed. Senator Quayle may have some questions.

Senator **Quayle**. I just have a statement that I want to put into the record, and also to express my interest to the chairman, in his absence, and the ranking member in trying to work together on a very important and substantive problem that we have.

I know that in my home State, I am shocked when I look at the statistics. When you look at recent graduates in 1982, four major universities in Indiana graduated a total of three people in chemistry, four in Earth sciences, and two in physics, who are qualified to teach their subjects in Indiana high schools. I mean there is just absolutely no way, gentlemen.

Are you getting prepared to adjourn or go to the next panel?

Senator **Pell**. We have another panel of people and we are trying to wrap up by quarter past twelve.

Senator **Quayle**. Well, in that case, I will insert my statement. It is an eloquent statement. I spent a lot of time on it, Senator Pell. [Laughter.]

[The opening statement of Senator Quayle follows:]

Opening Statement of Senator Quayle

Senator **Quayle**. Mr. Chairman, I must first thank you for organizing these hearings on what is of real concern to me. As you know, I have been especially interested in the areas of job training, worker retraining, and vocational training generally in the past 2 years. I think I know something of the problems of the unemployed, the displaced workers, and the poorly trained people looking for work in America today.

We have before us today a problem which is just as big, and just as important for the long-run economic recovery and growth of America Those of us in the industrial Midwest and Northeast know there is a problem with out supply of skilled workers. We know that we need a more scientifically literate labor force. And most importantly, we are concerned that our reserve of well-trained and educated scientists, thinkers and creators of jobs may be falling behind.

I know our guests today will go into some detail about the severity of this problem, but I would just like to highlight my own State's situation:

In 1982 Indiana's four major universities graduated a total of three people in chemistry, four in Earth science, four in general science, and two in physics who were qualified to teach the subjects in Indiana secondary schools.

Since 1977, there has been a steady decline in math scores for entering Purdue University students. More than one-third of Purdue students are unprepared for college calculus and must take remedial math courses.

In 1982 Indiana's major State universities graduated sufficient mathematics teachers to fill only 58 percent of the vacancies listed in Indiana schools.

Indiana, at a time of critical need for training, retraining, and preparation for industries of the future, requires only 1 year of high school science and 1 year of mathematics for graduation.

The statistics for our Nation as a whole, and particularly our standing internationally, are just as dismal:

In the U.S.S.R., East Germany, the P.R.C. and Japan, the school year averages 240 days, compared with 180 days in the United States.

The secondary school system in these same countries is a balance of science and math together with social science, languages, and humanities. Students must carry seven to nine courses a semester to accommodate the demanding curriculum.

English is the language of science around the world. Today there are more adults learning English in China than there are English speaking people in the United States.

Mr. Chairman, I believe this situation points toward a crisis, not just this year in whether we can fill all our teaching positions, but on into the future, in America's ability to compete in a free world market, and to defend that free market from its adversaries.

I am certainly not one who believes the Federal Government must try to solve every crisis in America's classrooms. But there is a Federal role here, and if properly narrowed and focused, the Federal Government can provide the resources needed for equal opportunity and access to excellence.

I believe we must explore incentives for our best teachers in the sciences to continue in teaching. William Raspberry's column in yesterday's Washington Post entitled "Paying Teachers More" may point the way toward action that must be taken at the State level. If we are seeking excellence, then we must recognize it in our schools, and we must pay for it.

There are many other issues I hope will be explored during these hearings. Among the questions I would like our panelists to address are:

One, should science and math teachers at the secondary level be recognized for their results—with teaching awards, salary bonuses, and incentives for quality work?

Two, what role should the Federal Government play vis-a-vis the States and local education agencies?

Three, how can we provide incentives for American business and industry—the ultimate consumers of a well-educated labor force—to become involved with math and science education earlier in the process?

Four, what should the role of our best colleges, universities, and schools of education be in this effort?

Five, should our best and brightest students receive our best attention, allowing the United States to compete on a world scale in an increasingly competitive world?

Again Mr. Chairman, thank you for your leadership in conducting these hearings, and I look forward to questioning and reviewing the testimony of all our witnesses.

Senator **Pell**. You are the chairman, if you can see the next panel through. Can you stick around?

Senator **Quayle**. I can stick around for 10 minutes. I guess we are going to conclude this in 15 minutes and we can call the next panel.

Senator **Pell**. You are chairman.

[Whereupon, Senator Quayle assumed the chair.]

Senator **Quayle**. I did not realize I was going to be chairman today.

Thank you very much for your input. I will read it in the record and look forward to working with you.

Which panel are we on?

Senator **Pell**. The second panel.

Senator **Quayle**. Dr. Forbes, Dr. Frazier, Dr. Lucas, Mr. Wolfenbarger, Dr. Smith, and Dr. Parent.

Senator **Pell**. And the record is staying open so that Senators can submit questions at a future date.

[Whereupon, Senator Pell resumed the chair.]

Senator **Pell**. Gentlemen, we are under considerable time pressures here, so my hope is that you could confine your talk to as short a period as possible. In fact, from the viewpoint of the Senators, the thing that we listen to most is when you make a point, one, two, three, four, and that stands in our memory. But when monotone reading goes on, you eventually get what we call the MEGO factor, the "mine eyes glaze over" factor.

So, I would wonder if the statements could appear in full in the record and if you would abbreviate them to make these very short points. Thank you.

First, working from left to right, we would ask Ms. Adler to start out.

STATEMENT OF SUSAN B. ADLER, DIRECTOR, WASHINGTON OFFICE, EDUCATION COMMISSION OF THE STATES, WASHINGTON, D.C.; CALVIN M. FRAZIER, COMMISSIONER OF EDUCATION, STATE OF COLORADO, DENVER, COLO., AND PRESIDENT, COUNCIL OF CHIEF STATE SCHOOL OFFICERS; ROBERT WOLFENBARGER, VICE PRESIDENT, NEW JERSEY STATE BOARD OF EDUCATION, SUMMIT, N.J., AND DIRECTOR, NATIONAL ASSOCIATION OF STATE BOARDS OF EDUCATION; ROBERT L. SMITH, EXECUTIVE DIRECTOR, COUNCIL FOR AMERICAN PRIVATE EDUCATION, WASHINGTON, D.C.; AND M. JOAN PARENT, FIRST VICE PRESIDENT, NATIONAL SCHOOL BOARDS ASSOCIATION, WASHINGTON, D.C.

Ms. **Adler**. Good morning, Mr. Chairman and members of the committee. I am Susan Adler, director of the Washington Office for the Education Commission of the States. Roy Forbes, lead staff person to our ECS Task Force on Education for Economic Growth was scheduled to testify here this morning but was unable to join you.

The same questions that Senator Stafford raised at the outset of this hearing which focused on: (1) looking at the scope of the problem, (2) looking at what kinds of initiatives are underway by the political and educational leadership within a State to deal with this problem, and (3) looking at appropriate roles for business and industry, are being addressed by our task force. Governor Jim Hunt of North Carolina, serves as task force chairman. Governor du Pont of Delaware and Frank Cary of IBM serve as cochairmen.

There is a blue sheet attached to my testimony that lists all the members of our task force. Many of the people on today's panel are members. Cal Frazier, to my left, serves as a task force member. The National School Board Association and the National Association of State Boards of Education also have representatives on our task force.

As our first goal, we set out to define with our members the scope of the problem. In answering that question, we built on the data that the National Assessment for Education Progress. The National Assessment has been housed with the Education Commission of the States for the last 13 years.

Senator Chiles mentioned this briefly in his testimony, and I would like to build on what he said. We have found, that students have made the greatest gains in the basic skills—how to multiply, how to read a sentence, how to do arithmetic. And, the most dramatic improvements were largely among students in the lowest 25 percent of those assessed.

The largest declines occurred for students in the highest achievement class, the students in the top 25 percent in each learning area evaluated. The problem-solving, critical thinking, analyzing, reasoning, the complex learning skills that we need in this modern technological society we are fast approaching, are the very skills that the majority of our students do not now have. In certain skill areas, up to 85 percent of our students are unable to demonstrate competence.

We took this information to our task force. The business representatives called those skills "learning to learn" skills; define the educators as "higher order/critical thinking skills." Our task force members also told us that we need to add to that skills definition attitudes, behaviors, and motivations—some of the kinds of comments that Senator Domenici mentioned this morning. Given this definition of the problem, the second goal of our task force is to address what a State and local policy leader—governor, legislator, State board member, chief State school officer—can do in his or her own State to increase the opportunities for our high school graduates to have and use these skills.

We are asking the kinds of questions that you are asking, Senator Pell. How do you create a learning environment in your State that motivates teachers and students? What changes in the educational delivery system do we need? Should we think about extending the length of the school day? What are the costs involved? What happens if business should be approached and asked to teach in the schools? How can that be done? Where is it already being done?

Our third area of focus concentrates on the appropriate responsibilities of business and industry. What are the incentives and disincentives for business to develop our partnerships with schools? What kind of framework does business need in order to make a long-term investment.

Our task force was established at the end of November. The first phase of our work, which concentrates on students in the K-12 school years, will end in July. We will have most of our recommendations in place by May. These recommendations will include suggested actions for each of our separate leadership groups—Governors, legislators, and State local school board members, chief State school officers, and corporate executive officers.

What we have found in our meetings therefore is that state leadership has moved ahead of the Federal Government in addressing this issue. In State after State, the framework is already being set in place. And, these are frameworks which seek to tie education directly to State plans for economic growth.

Senator Pell, I mentioned on page 3 of my testimony the Murray Commission operating now in your State. You probably know that this commission is composed of Rhode Island State and local business leaders, and the Governor's own people from the State Departments of Labor, Economic Development, Education. Governor Garrahy has asked the commission to give him an economic blueprint by April of Rhode Island's development needs and where education fits into these needs.

I am encouraged in listening to your hearing this morning. The manner in which you have framed your bill, the Education for Economic Security Act, must be the way to address this problem. Education must be considered a key component of whatever economic strategies are developed to deal with our short-term and long-term economic needs.

I will stop there.

[The prepared statement of Ms. Adler follows:]

STATEMENT OF SUSAN B. ADLER
DIRECTOR, WASHINGTON OFFICE
EDUCATION COMMISSION OF THE STATES

BEFORE THE

SUBCOMMITTEE ON EDUCATION, ARTS AND THE HUMANITIES
COMMITTEE ON LABOR AND HUMAN RESOURCES
UNITED STATES SENATE

HEARINGS ON

THE EDUCATION FOR ECONOMIC SECURITY ACT

AND

RELATED SCIENCE AND MATHEMATICS LEGISLATION

March 8, 1983

Mr. Chairman and Members of the Committee:

I am Susan Adler, Director of the Washington Office for the Education Commission of the States (ECS). In addressing the three questions which the Committee has asked, I would like to share with you the work of the ECS National Task Force on Education for Economic Growth chaired by Governor James B. Hunt of North Carolina and highlight for you recent National Assessment findings on student skills and achievement. I appreciate the opportunity to appear before you today.

Let me begin by endorsing the title of the Pell-Stafford bill, which I understand has a number of cosponsors. "The Education for Economic Security Act" sets an appropriate framework for discussion of the importance of education's place in the design of economic strategies necessary to move us faster toward recovery and forward to sustained economic growth. To succeed, this agenda requires many partners. State and local political and education leaders, business, labor and the scientific communities, have, in many instances, and through many different approaches, begun to address both the short- and long-range issues. The federal government would be welcomed as an additional partner in these efforts.

Through the ECS Task Force, begun this past November, and scheduled to complete the first thrust of its work this July, we are defining the scope of the problem, defining what state and local political leaders can do to address the problem, and outlining appropriate roles for business and private industry. We are collecting data on state initiatives under way. We are learning what the problems and complications are for state, local, business and education leaders. Within the next two months, we will be drawing together a range of suggested options for consideration and adaptation by individuals in leadership positions. I would like to highlight for you our thinking at this time.

This is more than a mathematics and science problem. The ECS Task Force has set as our first goal creating a national awareness of the kinds of skills, attitudes, and behaviors needed by our high school graduates to give them the necessary background preparation for meeting the demands and opportunities of a modern technological society. Our present work is concentrated on the student population in grades K-12.

You may know that the National Assessment for Educational Progress (NAEP), a national census measuring how students perform in key learning areas over time, has been housed at the Education Commission of the States for the last 13 years. Mathematics and science are two of the areas in which student abilities are evaluated. What we have found over the last decade is that the vast majority of students have mastered the basics, i.e., low-level reading, writing and arithmetic skills. In addition, many of the NAEP findings indicate stability or progress through the seventies (especially the late seventies) in literal comprehension, writing mechanics and computational skills. The most dramatic improvements were largely among students in the lowest 25% of those assessed. Many believe that a direct connection can be made between the influx of federal dollars targeted toward disadvantaged students over these years and their improved performance in the "basic skills."

The largest declines, however, occurred for students in the highest achievement class--the best students in each learning area evaluated. All our findings point to problems with what educators call higher-order skills and what business defines as learning-to-learn skills--the ability to reason, to problem-solve, to analyze, to infer and interpret. Why the decline? Many suggest that to a large extent, these skills are neither taught nor practiced in our schools. Students, instead, are taught specific, discrete skills, not general skills; concepts, not how to conceptualize. Problem-solving strategies have not been consistently built into our teaching methods and curriculum designs. I have attached to my testimony a recent paper prepared by our National Assessment staff that reviews these and other findings through raising the kinds of policy questions which members of this Committee may be asking.

Governors, legislators and state and local education leaders comprise over half the members of the ECS Task Force on Education for Economic Growth. Given the fact that the "critical thinking" skills so necessary for our future economic security are precisely those skills that the majority of our high school students are not mastering, our Task Force is concentrating on what strategies individuals in these leadership positions could be using to address this situation in their own states. We are addressing such questions as: What changes should we make in delivering educational services? How can we arrange for students to spend more time learning mathematics and science? Should we lengthen the school day or year? Should the states consider approaches to allow business people or scientists employed by industry or government to teach in classrooms? Which states have already succeeded in making schools more effective? What are the problems, costs, and unknowns when local and state leaders embark on programs to improve or reform their schools? Who opposes change, and why? Which state leaders can make the most significant commitments if schools are to be improved?

The remaining half of our Task Force consists of corporate executive officers from business, labor and industry. Frank Cary, immediate past chairman of the board of IBM, co-chairs our Task Force with Governor Pete du Pont of Delaware. We are working with these members to explore ways for leaders at the state and local levels to promote partnerships with business and industry, with the private partner sharing some part of the cost, human and material, of improving schools.

In this regard, the Task Force is collecting information on the kinds of partnerships that are already working and has begun compiling answers to important questions that proponents of such partnerships must answer: What framework is required if business is to remain an active partner with schools over a sustained period of time? What guidelines, regulations, and laws inhibit or encourage public/private partnerships of this kind? What are business leaders already doing to improve education? Which companies are helping schools identify the mathematics and science skills needed for jobs (and future growth) in the new technologies? To what extent are business executives lending their skills to school people who want to improve management? Which companies are exchanging staff with schools, or releasing mathematicians and scientists for service in schools? And with what pay-offs for both partners?

We are finding that perhaps one of the most valuable outcomes of our meetings thus far has been to realize that processes for addressing these issues are already under way in many states. Whether the approach involves statewide task forces, advisory councils, or special planning committees, the leadership within the state seems to have set in motion a framework which is structured to draw together a comprehensive look at all the pieces and the players which are necessary if economic stability in the state is to be achieved and if education is to play a significant part in this effort. Let me cite two examples--Rhode Island and Connecticut.

Senator Pell probably knows of Governor Garrahy's Strategic Development Commission, often known as the Murray Commission. In September of last year, 19 prominent leaders from Rhode Island business, labor, and education communities were appointed by the Governor and asked to develop a blueprint for Rhode Island's economic future. With J. Terrence Murray, chairman of the board and CEO of Fleet Financial Group as chairman of the Governor's Commission, work has focused on defining an accurate picture of Rhode Island's economic problems and helping to forge a consensus among business, labor, government and consumers on actions to be taken by each of these groups on major directions for the state's future growth. Each Commission member has contributed between 10 and 20 hours a week to this project.

The Commission will present its report this April. This report will contain policy recommendations to further strengthen the relationship between the state's educational and economic communities. All policy recommendations are designed to result in a targeted economic development strategy for the state.

It is expected that the Governor will use the Commission's recommendations in the design of his state legislative package on economic development. I understand that $8 million are already in place, with funding to begin July 1, 1983, to develop an enhanced computer literacy in every public school and institution of higher education in the state. Elementary and secondary schools will receive $3 million, vocational technical schools, $1 million, and institutions of higher education, $4 million. All companies involved in supplying computer equipment must also provide teacher training.

In Connecticut, this process is being carried out through the Governor's High Technology Council. The Council, whose members were named on January 11 of this year, is bringing together in one comprehensive planning effort, leaders in business, labor, the academic community, and state government. Lieutenant Governor Joe Fauliso is Council Chairman. The Governor has asked the Council to define, in the broadest sense, the kind of education the state needs for the information age, and to address retraining efforts necessary which will utilize resources from such areas as education, labor, labor unions, and corporations for economic development.

In the Fall of 1982, Governor O'Neil announced a $17 million high technology initiative as a first step toward addressing the longer-range economic strategies the state must face in the eighties and nineties. This initiative, which is now before the general assembly, includes:

- $4.5 million to purchase high technology equipment and instructional materials for the Regional Vocational Technical Schools and the comprehensive high schools;

- $250,000 for the State Department of Education's "Jobs for Connecticut Youth" program to help minority disadvantaged young people between the ages of 14 and 21, both in and out of school (the state funds will be matched by $255,000 in a private foundation grant);

- $700,000 to double the job training and retraining programs of the State Department of Labor, with the additional funds to be directed to retraining projects for workers displaced by high technology innovations;

- $7 million to be used as risk capital and seed money by the Connecticut Product Development Corporation (with a $1 million federal match);

- $3.5 million to be channeled through the State Board of Higher Education for an "Applied Projects Fund" and to upgrade existing programs and create new programs in high technology; and

- $100,000 for ten state scholarships for exceptional students who wish to pursue graduate education in Connecticut in high technology fields.

While funding would be limited at this time, a process for involving all the state's services and planning mechanisms to address the needs for economic development, retraining, and education at the elementary, secondary, and postsecondary levels is now in place through the Governor's High Technology Council. New federal dollars, through such opportunities as the successful passage of the Education for Economic Security Act, would be welcome as an additional partner to these efforts. Federal funding that recognizes and takes advantage of the mechanisms and activities already under way in states like Rhode Island and Connecticut could be leveraged to the best advantages of all partners involved.

Thank you.

National Task Force on Education for Economic Growth

Sponsor The Education Commission of the States (ECS), under the chairmanship of Governor James B. Hunt Jr. (North Carolina), current ECS Chairman.

Co-Chairmen The Honorable Pierre S. duPont IV, Governor of Delaware
Frank Cary, Chairman, IBM

Membership Thirty-five national leaders, including governors, legislators, heads of major corporations, education officials and representatives from labor, media and the scientific community compose the task force. Other business, industry, labor, education and government leaders will provide a network of knowledgeable advisors to the task force.

Purpose The task force will be action oriented . . . draw heavily on relevant data and resources that already exist . . . focus primarily on strategies for improving the quality of high school graduates, especially those skills required for economic growth . . . and give momentum to the growing interest and concern among governors and corporate leaders for the quality of our public schools.

Specifically, the goals of the task force are:

1. Create national understanding of the need for a well educated work force and the changing work skills that are necessary for economic growth.

2. Promote policies, programs and actions to improve education which may be used by national, state and local leaders in both the public and private sectors.

3. Establish partnerships among community, business, labor, government and education leaders to improve education that will lead to economic growth.

Although the focus will be on education for economic growth, the task force will remain cognizant of other equally important purposes of public education, e.g., citizenship and personal growth.

Meetings The task force will officially meet in Washington, D.C., on February 26 and in Raleigh, North Carolina, on May 4, 1983. Additionally, planning sessions attended by task force members or their designated staff were held in November 1982 and January 1983, with at least one more planned for April.

Reports

The task force will make reports to the 1983 annual meetings of the Education Commission of the States (Denver, July 20-23) and the National Governors Association (Maine, July 31-August 2).

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The Honorable LAMAR ALEXANDER, Governor of Tennessee

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The Honorable RICHARD L. THORNBURGH, Governor of Pennsylvania

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NATIONAL ASSESSMENT FINDINGS AND EDUCATIONAL POLICY QUESTIONS

No. SY-CA-50

an exploratory paper by
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Education Commission of the States

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The National Assessment of Educational Progress is an education research project mandated by Congress to collect and report data, over time, on the performance of young Americans in various learning areas. National Assessment makes available information on assessment procedures and materials to state and local education agencies and others.

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PREFACE

Since the National Assessment began in the late sixties, considerable energy has been devoted to methodological and technical aspects of assessment design, item development, sampling procedures and analytic strategies. During the seventies, many states created their own assessments and turned to NAEP for technical advice, assessment materials and networks such as the Large Scale Assessment Conference, where they could share technical concerns and expertise. Procedural and methodological matters understandably overshadowed utility questions until only a few years ago. But questions about how NAEP information -- or any assessment information -- is used or might be used by a variety of education actors and decision makers have grown increasingly pressing as the project's importance and visibility have grown.

Of particular interest -- because it affects school participation in the assessment and participation affects the accuracy of assessment results -- has been the utility of NAEP results for schools and school districts. How can national and regional data -- necessarily abstract and removed from day-to-day realities of any particular school -- have any significant impact upon classroom practices?

This special study addresses that question. Unlike other special studies (e.g., "Students from Homes in Which a Language Other Than English Dominates"), this paper does not showcase a secondary analysis of NAEP data. Rather, it represents a "repackaging" of existing data to answer some common questions about educational achievement, to relate the findings to past and future educational policy decisions and to raise questions for future research efforts.

The purpose of the paper is to provide a busy education leader with a "skeleton key" to the NAEP data base: a short overview of intriguing findings organized around topics likely to come up in speeches, articles or briefings. The arbitrary selection of findings and the interpretive judgments about them are the responsibility of the author only. Readers are encouraged to form their own opinions about the significance of these findings and are given specific references to the reports from which the findings derive, in case they want to pursue something to a deeper level of detail. We expect this paper to grow as additional findings are offered by other readers.

Many of the answers to questions and the recommendations for action in this paper could be buttressed through reference to research findings about learning in reading, writing, mathematics and science, as well as research on effective teaching and effective schools. As a next step, we will be indexing findings and interpretations to appropriate research, looking for convergence and divergence of views. Having done that, we intend to extrapolate those findings of greatest utility to two policy groups with great influence upon the classroom: curriculum guide writers and textbook selectors. We have already begun to learn exactly how and when each group uses various kinds of information, and we will be working with them during 1983 to perfect a model that satisfies their needs.

In the meantime, here is a paper that offers easy access to a huge data base, some food for thought and some recommendations for action. We invite reader response and welcome any insights or observations that would improve the effectiveness of this kind of effort.

Beverly Anderson
Director
National Assessment of
Educational Progress

NATIONAL ASSESSMENT FINDINGS AND EDUCATIONAL POLICY QUESTIONS

This paper is intended to provide a bird's eye view of the National Assessment of Educational Progress's (NAEP) huge data base and to stimulate some thought about what 13 years of data collected about over 1,000,000 students can tell us about American education. From the thousands and thousands of assessment results already published, we have selected 63 findings from five assessment areas. We could have selected many more findings from all 10 areas and the four probes NAEP has administered, but the purpose of this paper is not to be comprehensive. The paper is meant to illustrate the fact that long-term assessment findings constitute a rich source of information, ideas and hypotheses about what is happening in American education. They should be used more widely than they are, especially in policy analysis and debate about the quality and the future of our educational system.

Readers can procede in one of two ways. They can read the discussion part of this paper, which follows immediately, and then examine the findings referred to throughout the discussion. Or, they can peruse the findings first and then come back and read the discussion. Since the paper is designed to facilitate speech writing or quick review for a briefing, it makes no difference which way the reader procedes.

The discussion section is organized around questions which staff at the Assessment and the Education Commission of the States (ECS) have often been asked. Readers may think of other questions, of course, and the findings may help answer them. Note that each finding is indexed to the report in which it appeared so that anyone interested in getting deeper into the data can easily do so. We would suggest that articles written about these findings be based upon the original publications instead of this overview, since the original publications contain all the appropriate methodological information and caveats.

The discussion here is by no means definitive. These are one writer's judgments, hunches and educated guesses, and readers will have to decide for themselves whether they make sense. They are offered in the interest of starting a dialogue that includes, as a key feature, interpretive use of assessment data. The paper will grow as we add to the data base, index findings to other research studies and gather feedback from readers with many different perspectives on education. And as it grows, we intend to package and repackage the data to address very specific policy activities such as selecting textbooks or creating curriculum guidelines.

QUESTIONS

"Do National Assessment data shed any light on the effectiveness of federal or state education policy during the seventies?"

Many of NAEP's findings separately and collectively suggest that federal and state equal educational opportunity policies, reading programs such as Right to Read and federal/state programs concentrating upon elementary education may well have had a positive impact upon student achievement. Consider the following points:

- Black students' performance improved over the decade at a faster rate than white students in reading, writing and mathematics (findings 1, 4, 17, 46).
- Reading performance remained relatively stable over the decade for teenagers and showed an improvement for 9-year-olds (findings 1, 3, 6).
- While reading remained stable, there were declines among teenagers in science and mathematics (findings 1, 3, 6, 42, 43, 55, 56, 57).
- Elementary students showed progress on language arts assessments, while older students did not (findings 1, 3, 6, 14-16).

Given the facts that, during the sixties and seventies black students were special policy targets, reading programs received more attention and resources than other programs and elementary schools were the primary beneficiaries of Title I and other monies, NAEP data provide strong circumstantial evidence that focused policy attention and focused resources may have had measurable impact upon educational achievement. At the very least, one can observe that the target groups and areas of federal policy did not show declines, whereas groups and areas ignored or downplayed by federal and state policies did show declines.

"Was there a need during the seventies to go back to the basics?"

National Assessment results suggest that, in general, the vast majority of students had mastered the basics, i.e., low-level reading, writing and arithmatic skills, even before the "back to the basics" movement (Brown 1981). In addition, many of the findings listed here indicate stability or progress through the seventies (especially the late seventies) in literal comprehension, writing mechanics and computational skills (findings 1, 3, 6, 18, 45). To be sure, there were always students with problems in the basics (see 20, 30-34), but the NAEP data do not support the claim that there was some new problem between 1969 and 1980 that required schools to go "back to the basics."

"If students were not doing badly on the basics, why were test scores going down throughout the seventies?"

Many, but not all, test scores were declining during the seventies, but the phenomenon was not necessarily caused by problems with the basic skills. In fact, findings 3, 6, 15, 16, 35-37, 44, 45 and 55-57 all point to problems with higher-order skills such as inference, analysis, interpretation or problem solving. Post hoc analyses of the Scholastic Aptitude Test (SAT) reveal that the greatest declines in that test also occurred among the items testing higher-level skills and state assessments (e.g., Illinois) have been finding the same pattern.

"What kinds of students accounted for the declines and improvements during the seventies?"

We have already noted that black students and some disadvantaged groups of students improved during the decade (e.g., finding 1). In addition, findings 2, 8, 9, 47 and 58 establish that the improvements were largely among the students in the lowest achievement class -- that is, those students who constitute the lowest 25 percent of the students in each assessment.

On the other hand, the largest declines occurred in the highest achievement class -- that is, among the best students in each assessment.

"What is the level of literacy in America today?"

It would appear from the reading and writing findings, and from NAEP's functional literacy assessments in the mid-seventies (NAEP 1976) that the vast majority of America's students are literate readers (close to 90 percent) and literate writers (probably close to 75 percent). However, the fact that declines have occurred in inferential comprehension and in more difficult writing tasks should be cause for concern. It would appear that a standard of literacy which was perfectly acceptable 10 to 15 years ago is rapidly becoming obsolete. To the extent that analytic, interpretive and evaluative literacy skills are increasingly demanded by an "Information Society," NAEP findings suggest that there is a growing illiteracy (see Gisi, Forbes 1982).

"Are bilingual programs helpful to students who are not literate in English?"

National Assessment findings do not bear directly on the efficacy of bilingual programs, but two studies provide some data which, in conjunction with other data, may help answer this question. Finding 1 indicates that Hispanic 9-year-olds improved faster than the nation as a whole during the seventies. We do not know if this was a consequence of bilingual programs, but we do know that the gain was 8.4 percentage points for Hispanic students in big city schools where perhaps there is more likelihood of exposure to bilingual programs.

Findings 10-12 suggest both positive and negative implications for bilingual programs of any kind (as opposed to those exclusively for Hispanics). These findings suggest that coming from a home in which a language other than English dominates:

- Is, in general, associated with lower reading performance.
- Is less associated with poor reading performance for students who are attending advantaged schools and come from homes rich in reading materials.
- Is associated with different age-to-age patterns for white, black and Hispanic students.

Thus, it would appear that home and school resources can make a difference in the reading performance of students from non-English-speaking families. On the other hand, there are clearly limits to what can be accomplished, especially when the language barrier is also accompanied by factors which generally tend to make students subjects of various kinds of discrimination: poverty, race or the necessity to attend schools with few resources.

"How well can America's students read, write and compute?"

Although NAEP findings are descriptive, not evaluative, NAEP has asked many professionals to interpret the findings qualitatively. A reading of the interpretive chapters of the reports upon which this paper rests reveals a general level of disappointment among these learning area professionals. Reading educators expressed pleasure at the general stability of results and the elementary school improvements, but were disappointed to see inferential comprehension decline. Writing educators were also pleased that changes were not as dramatic as the press and public believed, but they felt performance on many writing tasks was lower than they would expect it to be. Interpreters of the literature assessment felt that performance on analytic, interpretive and evaluative tasks was far lower than they would like to see. Mathematics educators testified in the U.S. Congress that they felt the results for word problems and problem-solving exercises were much too low. And science educators felt that, although the rise in performance on biology exercises was commendable, those exercises were the easiest. They were distressed to see the physical science exercise results continue downward.

These were the opinions of only a few people, of course, and they were tempered by very positive statements about improvements in some areas and for some students. But, in general, the educators, who may have had higher educational standards and ideals than most people, felt student achievement -- particularly in high school -- could and should be improved.

"Will minimum competency tests raise student achievement?"

As political or public relations tools or as catalysts for renewed commitment, greater cooperation among teachers and administrators or clearer goal definition, minimum competency tests might conceivably improve student achievement. However, the foregoing discussion should have made it clear by now that the problems are not so much with minimum competencies as they are with maximum competencies. This being the case, focusing of energy upon the teaching and testing of low-level skills is not likely to have any effect upon the more serious problems suggested by NAEP data. Indeed, such a focusing might exacerbate the problem even more by ignoring the higher skills and the need to challenge all students.

"What factors that we can do something about seem most likely to influence these performance trends?"

Whenever we see a decline in the level at which students are performing some skill or set of skills, the number one hypothesis for the decline should be that the skill or set of skills is not being taught. Findings 22-26 suggest that very little writing is going on in the schools and there is very little comprehensive writing instruction available. It is reasonable to suppose that improved training of teachers and an increase in the amount of writing required of students would bring about a noticeable improvement in writing performance.

The same principle applies to the other areas as well. Declines in analytic skills (finding 36) suggest that students get few opportunities to practice them. Many of the literature results (35-40) can be explained in terms of standard classroom practice, which emphasizes brief oral comments from students rather than sustained inquiry or written analysis. Findings 27 and 29 suggest that students read for only short bursts of time; findings 33 and 34 suggest that many teenagers are in the habit of not finishing what they read; finding 29 suggests that a lot of time that could be spent reading is spent watching television.

Another factor that appears to influence performance is homework. Finding 13 demonstrates that students who are doing homework perform better than those who are not.

What these and many other NAEP and research findings add up to is this: if teachers are well prepared and if students are exposed to certain skills and spend time practicing them, performance improves. We know that, during the seventies, considerable time and resources were devoted to improving elementary students' reading skills and the results reflect a payoff. We know that far less time and fewer resources were devoted to mathematics and science, and the results reflect the natural consequences of that situation as well.

Beyond these general, easy to control factors, there are a number of specific suggestions for teachers in NAEP reports and many more could be culled from the professional literature. Some outstanding ones:

Reading and Literature

- Stress inferential as well as literal comprehension skills.
- Cultivate interest in reading that will get students reading and keep them reading for longer periods of time.
- Make students write about what they read.
- Encourage students to make more than quick, superficial responses to their reading.
- Don't do all the hard thinking for the students. Let them do it. Some studies suggest that many writing teachers make the hard organizational and structural decisions for their students, leaving the students to "fill in blanks."

Writing

- Have students write.
- Make students write in a variety of discourse modes (e.g., persuasion, description, etc.) and for a variety of audiences.
- Recognize that grammar and correcting errors are only two aspects of writing and should not be overstressed. (Note findings 18 and 19, for instance: errors in usage and mechanics stayed the same through the decade, but some writing skills declined anyway.)
- Provide prewriting training, and oral and written feedback on papers.
- Require students to rewrite papers once they have been fully diagnosed.

Mathematics and Science

- Take advantage of calculators as devices students can use to check their work and as handy teaching tools.
- Do not wait until students have mastered computation skills before going on to problem solving. Both can be taught at the same time.
- Give students the opportunity to interact with one another in exploratory projects (see finding 54).
- Take advantage of the good will students have toward both science and mathematics (findings 49-53, 62).

Each of these general teaching recommendations can be fleshed out in much more detail and all have been tied to very specific "how to's" in various publications for educators in all these areas.

Having established a list of "how to's" for teachers, it is necessary to establish the conditions under which they are able or unable to carry them out. The most obvious constraints are their own knowledge, their time, their other assignments, their materials and their support systems. These are all factors over which principals, schools of education, teacher accrediting agencies and other administrators can exercise control.

The next question to ask is, "What are the conditions that enable principals, administrators, schools of education and so on to provide teachers with what they need to get the job done, and what are the conditions that prevent them from doing so?" Answers to those questions move us farther and farther up the education hierarchy through state boards of education, departments of education, postsecondary governing boards, etc. and into the realm of laws and policies affecting the choices and degrees of freedom enjoyed by each of the many actors collaborating to make education work. This kind of "backward mapping" from the needs identified by NAEP data to the activities of each major actor and to the laws and policies affecting those actors is a strategy we cannot fully pursue in this short paper. But it is pursued somewhat in the next question, and future ECS reports will be devoted to more extended backward mapping.

"What new policy directions or guidelines are suggested by these findings?"

Since it appears that a concerted, relatively long-term policy focus upon disadvantaged youngsters, reading and elementary schools may well have affected achievement during the seventies, there is reason to hope that an even broader policy commitment could also lead to positive developments. The NAEP findings suggest that such a policy might aim to:

- Continue the momentum gained during the seventies in helping disadvantaged students. Although they have made encouraging strides, they remain, as a group, below national levels of achievement.

- Focus more attention upon mathematics and science. This is already happening in many states; the important thing, however, is that the focus should be long-term.

- Redefine the goals of education as encompassing more than "basics" or minimum competencies. This could be done through reference not only to NAEP findings, but to the many social changes that are rendering earlier standards of literacy and achievement obsolete.

- Attend to the needs of the best students, as well as the poorest students.

What would such broad policy guidelines mean for the many actors in American education? Here are a few suggestions:

Federal Agencies

- The Department of Education can publicize the need to get beyond the basics if American education is to provide a work force capable of competing for world markets and a citizenry in tune with the "information age."

- The National Institute of Education can encourage research into the causes of erosion in the higher-level skills performance of top students (see questions raised below).

- The National Science Foundation can press for renewed attention to science and mathematics and research into the causes of declines in those areas.

- The U.S. Congress can pass legislation which creates incentives for the private sector to devote resources to the schools and create a closer partnership between business and education.

Governors

- Call attention to both the good and bad news in these findings through state-of-the-state addresses.

- Establish commissions to determine the extent to which these national trends match state trends, to recommend coordinated approaches to the higher-level skill problems and to redefine the state's educational goals and commitments.

- Encourage private sector support for innovative educational programs through speeches, state blue ribbon commissions and proposed legislation.

State Legislators

- View education expenditures as critical investments in the human capital that will attract business and industry to the state and insure a viable state economy.
- Create incentives for private sector support of schools and for a stronger postsecondary/secondary school partnership.
- Provide financial and other incentives for good teachers to stay in the schools.
- Provide tax and other incentives for educational software development, and help establish guidelines to insure appropriate and constructive use of educational technology.

State Departments of Education

- Review tests and assessments to establish the extent to which the state's trends mirror the national trends.
- Establish curricular guidelines dealing with:
  - The acquisition of inferential comprehension and a commitment to reading.
  - The use of writing in any subject area as a way of promoting analytical, interpretive and evaluative skills.
  - Methods of stimulating more student writing of many different kinds and discouraging overattention to sentence-level instruction.
  - Students' boredom with "dumbed down" books, their fear of writing, anxiety about mathematics and resistance to senior high school science programs.
  - The need to go beyond retelling in response to written material.
  - Word problems and problem-solving skills.
  - The integration of the calculator and computer into the mathematics curriculum.

  - Scientific literacy for all students.
  - Exercises, assignments, activities that challenge even the best students.

- Provide technical assistance to schools and districts, with particular attention to inservice training in the development of problem-solving teaching strategies.

- Assist textbook selection committees by providing achievement and research information and guidelines for evaluating the degree to which books offer sufficient interest and challenge to all students.

- Develop assessment and record-keeping systems to monitor statewide progress on both low-level and higher-level competencies.

- Institute reviews, through teacher licensing and certification boards, of the course work required of teachers. To the extent current requirements do not involve sufficient training in teaching higher-level skills or adequate content course coverage, revise the requirements.

State or District Textbook Selection Committees

- Solicit reviews of current textbooks to determine the degree to which their language, questions and associated workbooks are underchallenging students.

- Develop specifications for textbooks that:
  - Promote analysis, synthesis, interpretation and evaluation.
  - Have proven interesting to the full range of students who will be using them.
  - Encourage writing, experimentation and discussion.
  - Do not fragment subjects so much students cannot see the forest for the trees.

- Give as much attention to substantive research issues as to the sociopolitical issues surrounding textbooks.

State Postsecondary Governing Boards

- Institute reviews of postsecondary programs and courses to determine the extent to which they only continue to promote a "basics" approach to learning.

- Encourage new courses for teachers that equip them to deal with the full range of student needs and abilities, that emphasize content knowledge and that convey the fruits of teacher effectiveness research.

- Work with postsecondary institutions to more effectively use admissions requirements as a means of increasing student enrollment in mathematics, science and other college preparatory courses.

- Join with state boards of education to promote greater cooperation between postsecondary institutions and public and private schools in reshaping education to address new needs.

"What major research questions do these findings raise?"

These findings and many more in the rich NAEP data base raise a number of intriguing questions which can only be answered by deeper study, further data collection and a host of quite different research approaches. Some major questions that have occurred to people familiar with the data are these:

- Why are the performance patterns of 9-year-olds, 13-year-olds and 17-year-olds so different from one another? The youngest students seem to keep improving, but their improvements do not seem to register four years later when the cohort group is 13. Is this happening because:
  - Elementary schools, junior high schools and high schools are distinct arenas, and changes in the lower grades do not necessarily pass on to the higher grades?
  - Not enough time has elapsed for improvements made in the late seventies to show up yet among older students?
  - Instruction and materials in the elementary grades are sufficient to stimulate short-term gains, but do not lay firm enough foundations to support students when they are older?

- Why, exactly, did low achievers make the gains they did? We have argued in this paper that their needs were more heavily attended to than ever before and that they were the targets of many federal and state programs. That is only one hypothesis, however, and it would be stronger if we knew which particular aspects of those programs were most successful in helping low achievers. Of course, other factors could play strong roles in their achievement, such as improved health, a rise in the proportion of such children whose parents have graduated from high school and so on.

- Why, exactly, has the high achievers' performance declined? Several hypotheses suggest themselves:
  - They were ignored or little attended to.
  - They took fewer academic courses and more electives.
  - The "basics"-oriented books and instructional approaches they were exposed to were unchallenging.
  - The foundation they were given in the early grades crumbled as they met greater demands in the higher grades.
- Why has performance on higher-level skills declined? Major testable hypotheses are:
  - They were not taught or practiced.
  - Students are taught specific, discrete skills, not general skills; concepts, not how to conceptualize; problem-solving algorithms, not problem-solving strategies.
  - Teachers do most of the hard thinking for the students, who are left to "fill in the blanks."
  - Pervasive multiple-choice testing of low-level skills has driven time and motivation for higher skills out of the classroom.

These are only a few of the research questions suggested by NAEP data; there are literally dozens more. The point in raising a few major research questions is simply to demonstrate one of the primary virtues of a broad, descriptive data base: it both answers and generates important questions for policy makers and researchers. National Assessment findings by themselves constitute facts that must be reckoned with in policy or research discussions. When coupled with other research findings and the judgments of experienced educators, NAEP data become formidable tools with which to analyze and explain the ups and downs of American education.

SIXTY-THREE FINDINGS IN FIVE LEARNING AREAS

National Assessments of Reading

Reading was assessed in the 1970-71, 1974-75 and 1979-80 school years. Each assessment included a wide range of passages and followup questions probing students' lower-level, literal comprehension skills and their higher-level, inferential comprehension skills. As in all national assessments, the materials used to measure change were identical in each assessment and had been kept secure. Stratified random national samples of 60,000 - 80,000 9-, 13- and 17-year-old students were assessed each year.

The reading reports in which the findings below are described fully are: Three National Assessments of Reading: Changes in Performance, 1970-80 (TNAR); Reading Comprehension of American Youth: Do They Understand What They Read? (RCA); "Students From Homes in Which English is Not the Dominant Language: Who Are They and How Well Do They Read?" (SFH); "Performance of Hispanic Students in Two National Assessments of Reading" (PHS). All are available through the Education Commission of the States Distribution Center, 300 Lincoln Tower, 1860 Lincoln Street, Denver, Colorado 80295.

Findings

1. Between 1971 and 1980, 9-year-olds' overall reading performance improved 3.9 percentage points. Groups that used to perform considerably below the national level improved their performance even more dramatically than the age group as a whole: blacks up 9.9 percentage points; southeasterners up 7.5; rural students up 6; and disadvantaged urban students up 5.2 percentage points (TNAR, pp. 7, 9). Hispanic students improved 5.3 percentage points between 1974 and 1980 (PHS, pp. 1, 5).
2. When the 9-year-olds' reading results are analyzed in terms of four levels of student achievement (from lowest to highest), it appears that all the improvement was in the bottom two achievement classes; students in the top two achievement classes performed at the same level throughout the decade (TNAR, p. 34).
3. The overall reading performance of 13-year-olds stayed the same through the seventies, although there was a slight improvement in literal comprehension skills (up 1.6 percentage points) (TNAR, p. 15).

4. Black 13-year-olds improved their overall reading performance 4.2 percentage points (TNAR, p. 17).

5. As at age 9, it is also the case that the bottom two achievement classes improved the most; however, the top achievement class dropped 2.4 percentage points (TNAR, p. 34).

6. Although the overall reading performance of 17-year-olds stayed the same through the seventies, their performance on inferential comprehension exercises declined by 2.1 percent (TNAR, p. 23).

7. There is no evidence at age 17 of the gains posted by disadvantaged youngsters at the earlier ages. For instance, 9-year-old blacks closed the gap between themselves and the nation by about 6 points; 13-year-olds closed it by a little over 3 points; but 17-year-old blacks made no comparable gains over the decade.

8. Of the four achievement groups, it is the top group -- the highest achievers -- who are declining most at age 17 in their overall reading performance (TNAR, p. 35).

9. The top two achievement groups exhibit the greatest declines in inferential comprehension over the decade: 4 percentage points (TNAR, p. 37).

10. Students from homes in which English is not the dominant language perform considerably below students for whom English is the dominant language on reading assessments. At age 9, the difference between them is 15 percentage points; at age 13, it is 12 percentage points; and at age 17, it is 8 percentage points (SFH, pp. 6, 20).

11. Some other language dominant (OL) students perform above the nation, particularly those attending advantaged urban schools and those coming from homes with many reading resources (SFH, pp. 7, 20, 21).

12. The gap between white OL students and the nation shrinks from age 9 to age 13 to age 17. The gap between Hispanic OL students and the nation remains much the same at ages 9, 13 and 17 (SFH, p. 6).

13. Seventeen-year-old students who had not been assigned homework the day before the assessment (31.5 percent of the total) performed 4.7 points below the nation on reading comprehension exercises. Those who reported doing more than 2 hours of homework (9.3 percent)

performed 5.1 percentage points above the nation (RCA, p. 6).

National Assessments of Writing

Writing was assessed in the 1969-70, 1973-74 and 1978-79 school years. Except for background questions about attitudes, courses taken and so on, the writing assessments use no multiple-choice measures of writing. They are based entirely on essays, letters and other such tasks, which are scored qualitatively, using holistic and primary trait approaches, and are described quantitatively in terms of such things as mechanics, syntax or coherence.

The writing reports in which the following findings are detailed are: Writing Achievement, 1969-70: Results from the Third National Writing Assessment: Volume I, 17-year-olds (VI), Volume II, 13-year-olds (V2) and Volume III, 9-year-olds (V3). All are available through the Education Commission of the States Distribution Center.

Findings

14. Between 1970 and 1979, the percentage of 9-year-olds' expressive essays rated 3 or 4 on a 4 point scale rose 6 percentage points. The percentage of quality narratives declined, while the percentage of good or excellent persuasive writing tasks stayed the same over the decade (V3, pp. 13, 16, 27, 32).

15. Between 1969 and 1978, there was a decline in the quality of 13-year-olds' descriptive essays, most of it taking place between 1969 and 1973. Thirteen-year-olds also showed declines in persuasive writing and in the coherence of their essays (V2, pp. 15, 16, 32).

16. Between 1969 and 1979, 17-year-olds' descriptive and explanatory writing performance did not change. However, their performance on persuasive writing tasks declined between 1974 and 1979 from 21 percent writing good papers to 15 percent (V1, pp. 12, 14, 20, 26, 31).

17. On most writing exercises, black students either improved at a faster rate than all students or stayed at the same level, while all students declined.

18. Error analysis of thousands of essays written in 1969-70, 1973-74 and 1978-79 reveals no real changes in the commission of such common errors as sentence fragments, run-on sentences, capitalization, punctuation, agreement or spelling. That is, students at all three ages continued to make about the same number of mistakes in

their first draft writing, on average throughout the decade (V1, pp. 42-46; V2, pp. 40-43; V3, pp. 40-43).

19. Analyses of the fluency and maturity of students' writing did not reveal any changes over the decade for the teenagers, although there were some slight changes for 9-year-olds (V1, pp. 40-42; V2, pp. 37-39; V3, pp. 37-40).

20. At all three ages, a sizeable proportion of young people -- 10 to 25 percent -- display very serious problems with writing (V1, p. 52; V2, p. 48; V3, p. 48).

21. At all three ages, about 20 to 25 percent of the students are fearful about writing, have a sense of doom about it and avoid it whenever they can (V1, pp. 142-143; V2, pp. 124-125; V3, pp. 44-45).

22. One-third of the 17-year-olds are doing some writing across all their courses -- at least one paper a week (V1, pp. 48-49).

23. Two-thirds of the 17-year-olds are not doing any appreciable writing in their classes (V1, pp. 48-49).

24. Eighty percent of the 17-year-olds spend a third or less of their English class time studying writing (V1, p. 48).

25. Sixty percent of the 17-year-olds get neither written suggestions back from the teacher on their papers nor discussions with the teacher about their work (V1, p. 49).

26. Only seven percent of the 17-year-olds appear to be receiving comprehensive writing training, i.e., training in prewriting, practice in improving papers and experience in getting good feedback from their teachers (V1, p. 49).

National Assessments of Literature

There have been two national literature assessments, the first in 1970-71 and the second in 1979-80, when literature was combined with reading. Much of the literature assessment involved asking students to respond in writing to various kinds of literature. The findings below are all discussed in detail in Reading, Thinking and Writing (RTW). Findings 27-29 are also discussed in Reading Comprehension of American Youth (RCA). Both are available through the Education Commission of the States Distribution Center.

Findings

27. When reading on their own, most teenagers read for less than one hour (RTW, p. 7; RCA, p. 5).

28. Most teenagers do no homework or less than one hour per night (RTW, p. 8; RCA, p. 6).

29. Most teenagers watch television for more than one hour per night: half the 13-year-olds watch three hours or more, as do one-third of the 17-year-olds (RTW, p. 8; RCA, p. 4).

30. More than a quarter of the teenagers say it is usually hard for them to finish a book they have started (RTW, p. 9).

31. One-third of the teenagers say it is hard keeping their minds on reading (RTW, p. 9).

32. Forty to fifty percent of the teenagers say it is hard for them to read materials with "new words" (RTW, p. 9).

33. One-third of the teenagers have problems finishing classroom silent reading (RTW, p. 9).

34. One-third of the teenagers say they have trouble finishing "long books" (RTW, p. 9).

35. When asked to respond to literary works and explain their response in writing by analyzing the work, very few teenagers demonstrated strong analytic skills. In fact, only five to 10 percent of them did so. Another 35 to 50 percent showed they had an inkling of what to do; 25 to 40 percent tended to "retell" the work (summarize the plot or main idea); and 10 to 15 percent proved unable to do it at all (RTW, pp. 15-24).

36. The percentage of 17-year-olds writing adequate analyses to substantiate their opinions about the mood of a literary work declined 10 percentage points between 1971 and 1980 (RTW, p. 23).

37. When asked to discuss theme and main idea of literary passages, students tended most frequently to retell the story or poem (RTW, pp. 33-46).

38. Students' written responses to literary works are heavily influenced by the work. If the characters and situations are close to the students' experience, they respond with a personal analysis, for instance. However, their personal responses were usually undeveloped, unsupported

and rather notional (e.g., "he shouldn't have said that to his father," etc.). And, over the seventies, the students became even more notional and judgmental (RTW, pp. 25-46).

39. Thirteen-year-olds tended to move away from retelling responses and more toward superficial evaluations and unsupported judgments (RTW, pp. 33-46).

40. Seventeen-year-olds tended to move away from responses based upon inferential leaps (right or wrong) and more toward "egocentric" responses (in which they talk mainly about themselves instead of the work) and superficial evaluations (RTW, pp. 33-46).

National Assessments of Mathematics

The first two mathematics assessments were in 1972-74 and 1977-78. Results from the third assessment (1981-82) will be reported in early 1983. The mathematics assessments involved a broad range of exercises assessing all aspects of the elementary and secondary mathematics curriculum except higher algebra, trigonometry or calculus.

The results mentioned below come from the following reports: Changes in Mathematical Achievement, 1973-78 (CMA); Mathematical Knowledge and Skill (MKS); Mathematical Application (MA); Mathematical Understanding (MU); Reading, Science and Mathematics Trends: A Closer Look (RSM); Mathematics Technical Report: Summary Volume (MTR); and Results from the Second Mathematics Assessment of the National Assessment of Educational Progress, published by the National Council of Teachers of Mathematics (NCTM). All but the last report are available through the Education Commission of the States Distribution Center.

Findings

41. The overall mathematics performance of 9-year-olds did not decline significantly between 1973 and 1978 (CMA, p. 1).

42. The overall mathematics performance of 13-year-olds declined 2 percentage points (CMA, p. 1).

43. The overall mathematics performance of 17-year-olds declined 3.6 percentage points (CMA, p. 1).

44. At all three ages, performance on knowledge exercises stayed the same or declined very slightly, but performance on problem-solving exercises declined dramatically: 5.9 percentage points at age 9; 3.4 points

at 13; and 4.0 points at age 17. In skills, 13-year-olds declined 2.0 percentage points and 17-year-olds declined 5.0 points (CMA, pp. 12-16; MA, pp. 1-25).

45. Inspite of declines, most students at all three ages demonstrated a high level of mastery of computational skills, especially those involving whole numbers. However, majorities at all three ages demonstrated weaknesses in such areas as geometry, measurement and probability (MA, pp. 13-20).

46. While other groups of 9- and 13-year-old students were showing declines in performance, black young people were not. Black 9-year-olds' overall performance improved 3 points and black 13-year-olds' overall performance remained stable (CMA, pp. 18-22).

47. At all three ages, the highest achievement class declined 3 to 4.3 points, while the lowest achievers did not decline at all (RSM, forthcoming).

48. Over 85 percent of the 17-year-olds in the assessment said they had access to a calculator. Results indicate that only half of the students are reasonably proficient in division as they near high school graduation. However, over 50 percent of the 9-year-olds and 90 percent of the 17-year-olds could do long division correctly with a calculator (MTR, pp. 120-135).

49. Teenagers rated mathematics as the most important of their school subjects (NCTM, p. 133).

50. Nine-year-olds rated mathematics as the best liked of five academic subjects; 13-year-olds rated it as the second best liked subject; and 17-year-olds rated it as the least liked subject (NCTM, p. 134).

51. Thirteen-year-olds said mathematics was the easiest of their academic subjects, but 17-year-olds rated it as the hardest (NCTM, p. 139, 140).

52. Over half the students at all three ages thought they were good at mathematics and said they enjoyed the subject (NCTM, p. 139, 140).

53. A large majority of students at all ages felt that a knowledge of mathematics was important in order to get a "good" job (NCTM, p. 141).

54. Students perceive their role in the mathematics classroom to be primarily passive. They feel they are supposed to sit and listen and watch the teacher work problems, then spend their remaining time working out problems alone.

They have little opportunity to interact with their classmates or take on exploratory projects (NCTM, p. 136).

National Assessments of Science

Science was assessed in the 1969-70, 1972-73 and 1976-77 school years. Changes in science achievement are based upon the responses of 17,000 to 29,000 respondents of each age to 70-92 exercises covering both the physical and biological sciences. The science findings are detailed in Three National Assessments of Science: Changes in Achievement, 1969-77 (TNA); Reading, Science and Mathematics Trends: A Closer Look (RSM); and Attitudes Toward Science (ATS). All are available through the Education Commission of the States Distribution Center.

55. Nine-year-olds declined on physical sciences exercises from 1969-77. However, they improved their performance on biology exercises between 1973 and 1977 (TNA, pp. 6-9).

56. Thirteen-year-olds followed the same pattern as 9-year-olds: a decline in physical sciences and an improvement, between 1972 and 1976, in biology (TNA, pp. 6-10).

57. Seventeen-year-olds declined in both the physical and biological sciences (TNA, pp. 6-11).

58. Declines in science were greatest among the highest achievers, especially white high achievers at ages 9 and 13 (RSM, forthcoming).

59. Teenagers list science as their fourth favorite course, behind mathematics, English and social studies (ATS, p. 5).

60. Forty-four percent of the 13-year-olds and 37 percent of the 17-year-olds say they always or often like their science classes (ATS, p. 6).

61. Eighty-one percent of the 17-year-olds said their science teacher "really likes science;" 48 percent said the teacher makes science exciting (ATS, p. 8).

62. About half the teenagers say they are interested in scientific careers (ATS, p. 12).

63. About a quarter of the teenagers think a scientific education for a career would cost too much (ATS, p. 15).

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Senator **Pell**. Thank you very much.

Dr. Frazier?

Dr. **Frazier**. Senator Pell, I do have nine points. I will begin with an overriding emphasis that I think has to come out of Congress and the administration. As I see the Federal role from my level, as State Education Commissioner in Colorado, the most important assistance is to set in motion those forces that bring together a Governor, legislators, State board members, local board members, the private sector, and educators, to address this problem in such a way that solutions and alternatives continue to unfold across this country, in the years to come rather than see the Federal legislation implemented in bits and pieces that never come together and leave the structure of education unchanged.

The system has to change or you will be back here in 3, 5, or 7 years debating again how much to allocate to school districts, State agencies or teacher education. We should be talking about a structural change, I think, in education.

So, taking these nine points very quickly: No. 1, in terms of any scholarship programs, I think they are good, they are visible, but that you have to go beyond this with additional legislation if you expect to have a long-lasting impact.

No. 2, there is value in supporting experienced teachers and recognizing outstanding talent. It is a morale boost that it needed, but I think that anything provided as a grant or a reward to experienced teachers ought to carry with it the expectation that the identified experienced teachers will continue over the life of this legislation to provide ideas to other school districts, to State leaders or institutions of higher education. We should tap this talent as a core resource in each of the 50 States.

No. 3, whatever is initiated should be built on an existing committee or operation. I like the idea of utilizing the chapter II grant because we have established a lot of the logistics. We ought to get quickly through the mechanics and into the implementation of any adopted legislation and keep the regulations and rules very simple.

No. 4, there ought to be a State commission that would bring together the leaders from science, math, and foreign languages, along with the State board, local board members and others. This commission would be charged with developing a plan for the State that would be implemented during the life of this particular legislation.

As far as a group that is not mentioned, in our own State, we have been including military representatives, since the military constitutes a rather large employment force. I think the legislation ought to encourage this kind of interaction.

No. 5, there are a lot of bills that are suggesting tax rebates to companies. I see one of the merits of a State plan in each of the States being a guide to businesses in that State. Tax rebates or tax credits could be achieved by fulfilling and supporting the attainment of the State plan.

I have found in my own contacts with business that they do not want to deal with a lot of segmented programs. They would like to know that they are contributing toward something that is going to have a major impact. I would like to see those proposed bills relating to tax credits tied to a State plan developed by a State commission.

No. 6, Congress ought to look at supporting a sequence through a 4-year cycle that would begin by granting the awards, but also putting the emphasis for the first year on a 1-year basis here on the development of a State plan. In the second year there would be a greater implementation of programs that would be statewide and concentrated on major factors that can affect the system of education. We should delay spending large amounts of money in school districts or in institutions of higher education until a State plan is developed.

Last, in closing let me just say that one of the best things that needs to come out of a national commission is something that provides local school districts, State boards, and others the details of how we compare with Japan and the Western European countries so that we have those kinds of detailed comparisons in front of us during our planning. There is an international element that ought to be in your Senate proposal, I think, to give meaning and credibility to the project as far as business and industry is concerned.

Thank you very much, and my remaining points are in the document.

[The prepared statement of Dr. Frazier follows:]

STATEMENT BY THE
COUNCIL OF CHIEF STATE SCHOOL OFFICERS
REGARDING FEDERAL ACTION TO ASSIST NATIONAL
PROBLEMS IN SCIENCE AND MATHEMATICS EDUCATION

I. Introduction

Mr. Chairman, I am Calvin Frazier, Commissioner of Education for the state of Colorado. I am here today as president and representative of the Council of Chief State School Officers (CCSSO). The Council is an independent organization composed of the commissioners and superintendents of education from each of the fifty states, six extra-territorial jurisdictions, and the District of Columbia. Members of the Council are the principal administrative officers of the public school systems in each state, and as such bear a heavy responsibility, along with our colleagues at the local level, for helping to insure that our children are well served by the nation's educational systems.

The purposes of my appearance today are to summarize the views of the Council regarding the national crisis we face in mathematics, science, foreign language, and technology education, and to provide some specific recommendations for federal action. The Council believes that the problems of improving mathematics and science education, and foreign language instruction can be effectively addressed at the national level by federal action. At the same time, our comments are based on the premise that the possibly effective approaches to this national problem depend on support from every governmental level, and a recognition that such solutions must address national priorities in the context of state and local needs.

II. CCSSO Views the Problem

The Council's view of the dimensions of the national problem we face in mathematics/science/foreign language/technology instruction can be expressed in the form of a series of propositions which we believe can form the basis for an appropriate national policy. These propositions, supported by the rationale for each and specific recommendations, are discussed more fully in the Council's policy statement, Need for a New "National Defense Education Act," a copy of which is appended to each copy of this statement.

Proposition One: There is a federal role in support of improved instruction in mathematics and science.

During the 1980s, the United States will experience an accelerating trend toward a focus on high technology industries, while also facing the challenge of increasing our national security and revitalizing basic industries. Our future security and physical and economic well-being will depend on how well America manages the task of investing in the education of tomorrow's citizens.

Proposition Two: The elements of federal legislation should include: incentives to increase the supply and upgrade the quality of the teaching profession, funds for equipment, support for youth activities, and support for other activities.

You will hear, Mr. Chairman, throughout these hearings about the scope of the problems faced by our schools. Let me simply point out a few examples: the state of California estimates an annual need for at least 1500 additional secondary science and mathematics teachers simply to cope with existing shortages. Similarly, some school districts in Maryland are unable to find a single trained, certified physics teacher to staff existing high school programs. This story is repeated throughout the country: too few qualified teachers and too little equipment is available to teach science, mathematics and technological subjects adequately. Recent figures from the National Science Foundation indicate that, nationwide, 16 percent of all elementary school teachers are not sufficiently prepared to provide basic training in science and mathematics. At the same time, the federal government's commitment to research and training in science education at the elementary and secondary levels has declined to almost nothing since the 1960s.

Proposition Three: Support for foreign language instruction is part of the federal role in support of education.

The Council believes that national security requires that we be able to understand major world cultures and political groups, and that trade and economic development in a global economy depend on our ability to communicate with trading partners. For these reasons, we believe steps must be taken to reverse the current decline in the foreign language proficiency of the American public. This is an appropriate area for federal support and action, as numerous members of this Committee have already indicated through the years.

Proposition Four: Federal support for math/science/technology education should be administered through states, should be coordinated with the numerous state-level initiatives in this area, and should be of sufficient scope to have a significant impact on the nation's schools.

Recent surveys by the Education Commission of the States indicate that, out of nearly forty states queried, all are implementing programs to improve educational quality. Such programs include: new science/mathematics curricula,inservice teacher training, increased use of computers in the classroom, and providing special programs to enhance teacher supply and quality. Kentucky, for example, has initiated at the state level a student loan forgiveness program for future science and mathematics teachers. At the same time, states have widely varying needs. In New York State, for example, 57 percent of high school students following an academic track take three or more years of science, while only 41 percent of such students nationally take as much science. Surveys also indicate that science teacher shortages vary by discipline and geographic area. National legislation, therefore, must provide the flexibility for state and local education agencies to be able to use funds in the areas of their own greatest needs.

Proposition Five: The federal role in the areas of math/science/foreign language/technology education is linked to the federal role in support of human capital development generally, as well as to defense preparedness through personnel preparation. Training for high technology occupations, math and science education, and defense preparedness are interrelated acitivities. Public school vocational-technical education programs can contribute directly to the needed manpower of the military services through specific training programs keyed to Military Occupational Specialty (MOS) needs. Both the private sector and the defense establishment can contribute to and benefit from national policies in these areas.

The number of young people is shrinking, while the needs of the nation for a better qualified technical workforce are well documented. Retraining of the existing workforce will be important, but much will depend on the types of training received by young people entering the workforce. There must be increased coordination of resources among the military, the private sector, and all levels of educational institutions. The Council has developed a number of recommendations for ways to stimulate such coordination, many of which are discussed in our statement. Others are to be found in the policy statement attached to copies of the statement.

Proposition Six: Both federal and state efforts to support improved instruction in math, science, technical fields and foreign languages should have a significant focus on increasing access and equity. The particular needs of women and minorities must be addressed in this national effort.

The Council believes that excellence in education means increased equity. Historically, women and minorities have been underrepresented in technical fields of study. For example, a 1980 estimate by the National Center for Education Statistics places the proportion of females taking three or more years of mathematics in high school at only 26 percent. Sixty percent of white students take geometry, but only 39 percent of black students do so. Women and minorities together make up more than 60 percent of the population, but a mere five to ten percent of the nation's engineers. It is part of the federal role in support of education, and the responsibilities of state and local education authorities, to find ways to take advantage of this resource.

Proposition Seven: Federal legislation to support mathematics, science, foreign language, and technical instruction must incorporate and assure an adequate level of financial support.

Previous federal efforts in the mathematics and science areas have been funded at fairly modest levels. Even the first incarnation of the National Defense Education Act was only modestly funded. The Council believes that federal education programs which in the past have been accused of "failure" have often simply been inadequately funded. A successful federal program, ECIA Chapter I, is funded at a level which provides about $450 support for each child served. Yet, it is a targeted program which only serves about half of those eligible, and the eligible population is relatively small. We believe the level of Federal effort in support of mathematics, science, foreign language and technological instruction should be at least on the same order of magnitude as ECIA Chapter I.

The point, therefore, is that for any significant positive efforts to be realized, funding must be at the level of billions rather than millions. In addition, a program must have continuity of funding over a period of several years in order to be integrated into local and state efforts. We recognize the severe budget constraints facing the federal government, but we also must urge the Congress to recognize the scope of this national problem.

III. What Are the Most Significant Short-term Issues?

As I said, the Council recognizes the budget constraints facing the Congress. At the same time, we believe that both the scale and the substantive aspects of the problems we face are beyond the capacity of any single piece of legislation to confront. Therefore, we have identified what we believe to be the three most significant short-term problems in the specific area of mathematics and science instruction in elementary and secondary schools:

One: Teacher Supply and Quality--Our problem is that there are simply not enough trained and qualified science and math teachers available. Thelack of adequate numbers of teachers forces the use of untrained teachers. Untrained teachers, besides the possibly poorer instruction they are able to provide, help to exacerbate the problem of too few science and mathematics majors.

Two: Equity and Excellence--As I have noted, educational excellence means equity: we need new curricula which match the stages of children's intellectual development; we need new science and mathematics equipment; we need, most of all, to have the means at hand to help all young people become scientifically literate and mathematically competent.

Three: Coordination Among Institutions--The problems we face are not unique to schools, and cannot be solved by state and local education agencies alone. Because the problems we face involve every part of our economy and educational structure, each level of government and social institution must help. Postsecondary educational institutions, the private sector, and government--including the military--must all be called upon to provide assistance, support, and cooperation with the schools in efforts to address these problems.

IV. Specific Recommendations for Federal Action

Fortunately, members of Congress, including specifically the Chairman and members of this Committee, have recognized the scope and nature of the problems we face. A number of bills have been introduced which address parts of the problems and needs I have discussed. At the same time, we believe that the the need for effective federal action could be met by adopting some of the suggestions discussed below. We have identified several outstanding issues which must be resolved, and offer several recommendations for ways to address each issue. We are not supporting any one of these recommendations to the exclusion of the others, but rather believe that each should be explored before the committee commits itself to one plan of legislative action.

Issue One: Federal funds must be concentrated on assuring that significant accomplishments are possible in a limited number of fields in which there are significant needs

It would enhance the prospects for success of programs under any federal legislation if funds could be carefully targeted to the areas of greatest need in the country, and to the aspects of the problem which are identified by states and localities as being most difficult. At least four additional possibilities, each of which would target funds more precisely on problem areas, should be considered as you develop legislation :

Competitive Grants Model--P.L. 90-35, the Education Professions Development Act, was developed to improve the quality of teaching and to help meet critical shortages of adequately trained personnel through the identification of needs in a state plan. The bill called for a state plan to meet state needs. In many cases, these plans were administered by state education agencies through the use of competitive grants which focused funds on local areas with the greatest needs. A federal program with clear goals, assigning responsibility for addressing state needs at the state level, could be similarly administered.

Use of Matching Funds--It is our belief that some matching requirements could leverage other federal, state or local funds. We think that the Committee should consider requiring matching funds from other sources for certain specific programs. We are concerned, however, that extensive federally prescribed programs not mandate the use of state and local funds in ways that may not be appropriate in all states. Again, there is a need to assign states a large degree of discretion in deciding how best to meet federal goals. Federal funding, such as ECIA Chapter Two, Vocational Education Act, ECIA Chapter One, and special education could be allowed to be counted as matching funds. Additionally, state and local funds or in-kind contributions, along with funds received from local business and industry, would count as matching funds.

Target any Basic Intrastate Distribution Formula--We suggest that any intrastate formula, if required, could be targeted using several factors, including: poverty (as a measure of the need for supplementary instructional services as in ECIA Ch.1), or measures of the teacher shortage in particular states (where satisfactory data are available). Whatever measures are used should be considered in light of the three major issues identified above, particularly including teacher supply and quality, and equity. Nationally, any formula must distribute funds equitably among the states, and that decision must be made by the Congress and/or the Secretary. However, the decision about how best to target any portion of the funds within each state should be made by state authorities, in consultation with local authorities within that state. No federal official, no matter how well informed, can know the exact needs within any one state, and needs vary widely among states, as we have shown.

Use Performance Bonuses--One way to address the need for additional coordination and cooperation among various social institutions would be to structure basic funding using a performance bonus concept. Thus, for example, if greater coordination among postsecondary institutions and local education agencies is to be desired, some funds should be made contingent upon the establishment of cooperative agreements. Similarly, if an LEA were able to obtain a significant percentage of funds from local business and industry, such a district could receive a performance bonus equal to perhaps ten percent of any basic grant.

Issue Two: Federal legislation can be most effective if it incorporates a significant state leadership role.

The promise of federal programs to provide meaningful assistance in addressing the three fundamental issues of teacher supply and quality, coordination among various institutions, and equity will be significantly increased by a significant state role. This could be accomplished in a variety of ways:

Give States Funds to Coordinate with State Initiatives--As noted above, the Education Commission of the States has surveyed the states and established that nearly all have significant state level activities proceeding in this area. States should have both the authority and the funds under any federal legislation to coordinate federal funds with state programs.

Give States A Significant Role in the Oversight of Inservice Training--In order effectively to address the qustions of teacher supply and quality, it would be best to tie all inservice training efforts to standards accepted by the state (although perhaps selected by local governing boards). States have on hand comprehensive inservice development plans required under previous federal legislation (Title IV of the Elementary and Secondary Education Act). In addition, many states have adopted state statutes or policies which require SEAs to oversee all inservice teacher development activities within the state in order to ensure that there is no duplication of services and that state needs are met.

Allow States to Conduct Inservice Activities Directly--State education agencies can and do have the capability to mount statewide programs of innovation, and such capabilities should be encouraged and supported. Moreover, in many states there are existing regional inservice teacher training and upgrading institutions maintained by state agencies. Legislation should explicitly allow SEAs to use funds to develop and conduct (or contract for) innovative projects to upgrade and train teachers, administrators, and others.

States Provide a Base for Institutional Coordination--State education agencies and state boards of education are key links in the task of assuring coordination and cooperation among levels of government, the private sector, and postsecondary education. Therefore, federal legislation should provide authority and responsibility to states to ensure the development of policies and activities which increase such coordination.

States Must Help Ensure Equity and Excellence--Graduation requirements and other performance standards, policies promoting the equitable treatment of women and minorities, and the development of substantive curriculum changes are all part of the responsibilities of states, and should be recognized in the structure of federal legislation.

Issue Three: Federal Legislation must address the fundamental issue of teacher supply and quality.

As I have noted, the Council believes that in the short run, one of the most significant problems we face is the supply and quality of the teaching staff necessary to accomplish the goals of increasing scientific literacy and mathematical competence. We believe the potential effectiveness of federal support could be enhanced by adoption of these recommendations:

Funnel Significant Funds to Summer Institutes--Experience suggests that summer institutes for science teachers, focused on both scientific subjects and pedagogy, are among the most effective ways to increase the skills of current faculty. Therefore, we suggest that significant funds should be devoted to such institutes, and that they should be operated in accordance with the goal of increased coordination among state agencies, postsecondary institutions, local education agencies, and the private sector. In many instances, state educational agencies are the most appropriate operators of summer institutes, as well as being necessary to the coordination process.

Authorize a Program of Fellowships for Existing Faculty--In order to help retain talented teachers in mathematics and science, we suggest that state boards of education be awarded special funds to provide fellowships for experienced secondary teachers of mathematics and science. The fellowships would provide for tuition, living expenses, and district substitution costs for a period of up to one semester of residence in a program which would upgrade teaching skills in the fellow's field. Upon successful completion of coursework, fellows would be awarded a bonus of up to $5,000 to be used for the purchase of necessary equipment and/or instructional materials to upgrade instruction in the fellow's classroom.

Provide Incentives for LEAs to Give Teachers Longer Contracts--One approach to upgrading the skills of teachers, and providing greater compensation without a differential salary scale, would be to authorize LEAs to use funds under this Act to give selected teachers 11-month contracts. The months when classes were not in session would be devoted to curriculum improvements, inservice, and other professional growth experiences. Similarly, provision could be made for coordinated activities with private industries interested in employing teachers for the summer months, as previously introduced legislation has suggested.

Focus Inservice Teacher Development on Equity Issues--Any federal legislation should explicitly encourage the use of funds for special teacher training and retraining efforts directed at overcoming sex and role stereoptypes which impede the progress of women and minorities in scientific and technological fields.

Provide a National Program of Significant Scholarships for Those who Intend to Teach Science and Mathematics--We believe a program of significant Congressional scholarships may provide an adequate incentive to talented young people wishing to enter the education profession. It would be extremely helpful to be sure that the size of the scholarships provides a genuine incentive for those who may enter the profession, and the time required to "repay" the assistance provided should be reasonable--three years would be appropriate. The Council also believes that a "performance incentive" could be developed for this program, as well. Each member of the House and Senate could be allowed to nominate more candidates if businesses and industries located in their districts or states were to donate half of the scholarship costs.

Issue Four: Federal legislation should provide adequate mechanisms of accountability from all fund recipients, and to assure that federal goals are being addressed. Adequate fiscal and program accountability are necessary to demonstrate the effectiveness of programs. Having experienced for several years the tender mercies of the auditors from the Education Department, who frequently appear to establish standards where none have been announced, we believe that federal legislation should include reasonable fiscal accountability standards. In addition, legislation would be strengthened by adoption of these recommendations:

States should be given the responsibility and authority for assuring program quality--Clearly, it is impractical to ask the nation's 16,000 local school systems to deal directly with the federal Education Department. At the same time, education programs within states must meet state and local educational and performance standards. Therefore, the Council suggests that legislation provide states the clear responsibility and authority for program accountability. Such provisions could include requirements for local plans to be reviewed at the state level, state-level evaluations of state and local program efforts, and other steps.

Accountability standards should take the form of performance standards and incentives--The Council suggests that one way to assure adequate, agreed-upon accountability standards for programs would be to build into federal legislation specific areas in which states would be required to develop performance standards. As a first step, we would include the three major problems already identified: teacher supply and quality, equity, and coordination among responsible institutions.

Issue Five: Federal legislation must contain a level of authorization that is sufficient to address at least the problems identified in legislation.
The Council recognizes the budget constraints faced by the Congress. Yet, the funding levels proposed in most of the legislation introduced to date are inadequate to deal substantively on a nationwide basis with any of even the most basic problems we have identified. The only suggestion we can offer is that you seriously consider providing substantial authorization levels in any legislation you develop. In addition, we must target funds carefully on both who is to be served and what aspects of the problem are to be addressed. As I mentioned earlier, the Council believes that, in the long run, federal support in this area must be of the same order of magnitude as that provided for ECIA Ch. 1. In addition, I urge you to find some way to assure predictable and continuous funding. Continuity of funding is vital if state and local agencies are to integrate programs funded under any federal Act with their own ongoing programs. Additionally, while we face a national emergency today, we will continue to face a severe national problem for the foreseeable future--we will always need support for the upgrading of teachers, incentives for coordination among various responsible institutions and levels of government, and ways to address the problems posed by equity and excellence considerations.

V. Conclusion

Members of the Council of Chief State School Officers commend you, Mr. Chairman, and the members of this committee for beginning to address the very real problems we face in attempting preserve national security and economic strength through educational improvements. You face a difficult task in attempting to define the problems which are most significant in this area, sort out the variety of proposals made to date, and create legislation which will provide the promise of an effective program. We believe that the suggestions we have made can be of significant assistance to you in accomplishing that task. Members of the Council support your efforts, and we are ready to work with you and with other organizations to assure that this major national issue is addressed effectively and thoughtfully. Thank you.

Senator **Pell**. Thank you very much.

Mr. Wolfenbarger?

Mr. **Wolfenbarger**. Thank you, Senator Pell. I am Robert Wolfenbarger. I am a director of the National Association of State Boards of Education, and vice president of the New Jersey State Board of Education. In my professional life, I am employed in New Jersey in the largest employer of scientific and technical talent in the State.

On behalf of all of the NASBE member boards, I want to thank you for the opportunity to testify on the issues. I do not think it is too much to say that if the Nation does not act decisively in the areas covered by this measure, we could well forfeit the American future.

We could lack scientifically and technologically trained people to compete effectively. We could be unable to meet the manpower needs of both our military and defense industries. That is why this legislative initiative is so important.

The State boards of education believe that the most urgent tasks that face us are, first, to identify and focus efforts on solving our most critical long- and short-term education, economic, and security problems; second, to concentrate resources in school systems where the need is most severe; third, to insure that as we do this, we pay attention to the special needs of the disadvantaged, women, the handicapped, or students who have little or no command of English.

Clearly, the most important problem we face is the critical shortage of math and science teachers, and particularly the growing need for teachers trained in the use and applications of computers. Everything else we do—updating curriculum, acquiring new equipment, or increasing years of study—will not be very effective if we do not have enough teachers qualified to meet the need.

A recent study by the Association of School, College, and University Staffing indicates that some 22 percent of all high school teaching posts in math are vacant. A 1981 study suggests that 42 States had shortages of physics instructors, and 38 shortages of chemistry teachers. Those shortages go on and on.

I can tell you, however, that in the State of New Jersey, the numerical shortage of teachers is not great. Indeed, in keeping with the decline in enrollment, we have a better student-teacher ratio than we have had in the past years.

Nonetheless, the problem remains one of quality, one of recency of training, and one of use of new equipment and instructional materials. So, although we may not have a numerical problem in the State of New Jersey and in several other States, we do have the problem of quality.

Of course, this is made more severe by the fact that many existing certified teachers in math and science really are not current in their fields. The greatest number of our teachers are in the ages between 31 to 40—almost half of the total math/science teachers in New Jersey. Regrettably, that also means they are 20 years from their most recent college training and 25 years from retirement.

Generally, our math and science teachers' age range runs slightly longer than teachers as a whole. These are some of the problems that we see in that shortage. We believe what is most urgently required is to concentrate on the new three R's—recruiting, retraining, and retaining first-rate teachers.

We not only need computers and high technology in the classroom, but teachers and students fully trained to use them.

I will insert my comments in the record.

[The prepared statement of Mr. Wolfenbarger follows:]

National Association of State Boards of Education

TESTIMONY

ON

THE EDUCATION FOR ECONOMIC SECURITY ACT

BY

ROBERT WOLFENBARGER

FOR

THE NATIONAL ASSOCIATION OF STATE BOARDS OF EDUCATIN

BEFORE THE

SENATE SUBCOMMITTEE ON EDUCATION ARTS AND HUMANITIES

MARCH 8, 1983

526 Hall of the States • 444 North Capitol St., N.W., • Washington, D.C. 20001
• (202) 624-5845 •

MY NAME IS ROBERT WOLFENBARGER. I AM A DIRECTOR OF THE NATIONAL ASSOCIATION OF STATE BOARDS OF EDUCATION, WHICH REPRESENTS EDUCATION POLICYMAKING BODIES IN NEARLY ALL STATES, THE DISTRICT OF COLUMBIA, AND U.S. TRUST TERRITORIES. I AM ALSO A MEMBER OF THE NEW JERSEY STATE BOARD OF EDUCATION. ON BEHALF OF ALL NASBE MEMBER BOARDS, MR. CHAIRMAN, I WISH TO THANK YOU FOR THIS OPPORTUNITY TO TESTIFY ON VITAL ISSUES RAISED BY THE EDUCATION FOR ECONOMIC SECURITY ACT.

I DO NOT THINK IT IS TOO MUCH TO SAY THAT IF THE NATION DOES NOT ACT DECISIVELY IN AREAS COVERED BY THIS MEASURE, WE MAY WELL FORFEIT THE AMERICAN FUTURE. WE WILL LACK THE SCIENTIFICALLY AND TECHNOLOGICALLY TRAINED PEOPLE TO COMPETE EFFECTIVELY IN DOMESTIC AND GLOBAL MARKETS, AND WE WILL BE UNABLE TO MEET THE MANPOWER NEEDS OF OUR MILITARY AND OUR DEFENSE INDUSTRIES IN PROVIDING FOR OUR NATIONAL SECURITY. WE ARE, THEREFORE, IN DEBT TO YOU MR. CHAIRMAN, TO SENATOR PELL, AND YOUR CO-SPONSORS FOR THIS LEGISLATIVE INITIATIVE.

STATE BOARDS OF EDUCATION ACROSS THE NATION BELIEVE THAT AMONG THE URGENT TASKS THE COUNTRY NOW FACES ARE (A) TO IDENTIFY AND FOCUS EFFORTS ON SOLVING OUR MOST CRITICAL LONG AND SHORT TERM EDUCATION, ECONOMIC AND SECURITY PROBLEMS, (B) TO CONCENTRATE RESOURCES IN SCHOOL SYSTEMS WHERE THE NEED IS MOST SEVERE, AND (C) TO ENSURE THAT WE RECONCILE THESE EFFORTS WITH ATTENTION TO THE SPECIAL NEEDS OF THE DISADVANTAGED, WOMEN, THE HANDICAPPED, OR STUDENTS WHO HAVE LITTLE OR NO COMMAND OF ENGLISH.

A. THE MOST URGENT PROBLEMS.

IN OUR VIEW, THE MOST URGENT PROBLEMS ARE THE CRITICAL SHORTAGES OF MATHEMATICS AND SCIENCE TEACHERS AND THE RAPIDLY GROWING NEED FOR TEACHERS TRAINED IN THE MULTIPLE USES OF COMPUTERS. ALL OTHER MEANS OF STRENGTHENING INSTRUCTION -- UPDATING CURRICULUM, ACQUIRING NEW EQUIPMENT, INCREASING THE YEARS OF REQUIRED STUDY -- WILL BE TO LITTLE AVAIL IF WE DO NOT HAVE ENOUGH TEACHERS QUALIFIED IN THESE AREAS -- AND WE SURELY DO NOT.

THE ASSOCIATION OF SCHOOL, COLLEGE AND UNIVERSITY STAFFING INDICATES THAT 22 PERCENT OF ALL HIGH SCHOOL TEACHING POSTS IN MATHEMATICS ARE VACANT. A 1981 SURVEY OF 45 STATES FOUND THAT 42 HAD SHORTAGES OF PHYSICS INSTRUCTORS AND 38 HAD SHORTAGES OF CHEMISTRY TEACHERS. THE NATIONAL SCIENCE BOARD REPORTS THAT FROM 1971 TO 1980, THE NUMBER OF STUDENT TEACHERS PLUNGED THREEFOLD IN SCIENCE AND FOURFOLD IN MATH -- AND ONLY HALF OF THAT GREATLY REDUCED NUMBER EVEN ENDED UP TEACHING.

THERE IS MUCH ADDITIONAL DISTURBING EVIDENCE OF THE SEVERITY OF THIS PROBLEM, AND I WILL APPEND A FULL LISTING TO THIS STATEMENT. BUT SUFFICE IT TO SAY THAT WE SHOULD BE ALARMED WHEN WE LEARN, AS I DID RECENTLY FROM A STATE BOARD MEMBER IN THE WEST, THAT HIS STATE IS USING PHYSICAL EDUCATION INSTRUCTORS TO TEACH SCIENCE, OR WHEN THE WALL STREET JOURNAL REPORTS THAT OKLAHOMA CITY IS USING BUSINESS AND SOCIAL STUDIES INSTRUCTORS TO TEACH MATH.

THIS INADEQUACY BECOMES COMPOUNDED BY THE FACT THAT MANY EXISTING AND CERTIFIED MATH AND SCIENCE TEACHERS ARE NOT CURRENT IN THEIR FIELDS. WE HAVE HAD TO FACE THIS PROBLEM IN NEW JERSEY, WHERE MANY OF OUR MATH AND SCIENCE TEACHERS ARE IN THE HIGHER AGE BRACKETS. WE ARE MINDFUL OF A NATIONAL COMMISSION FINDING THAT INADEQUATELY PREPARED TEACHERS ARE "A PRIME CONTRIBUTING CAUSE OF DECREASING STUDENT PARTICIPATION AND ACHIEVEMENT IN MATHEMATICS, SCIENCE AND TECHNOLOGY".

BECAUSE OF ALL THIS, WE BELIEVE THAT WHAT IS MOST URGENTLY REQUIRED IS WHAT MIGHT BE CALLED EDUCATION'S NEW THREE RS -- RECRUITING, RETRAINING AND RETAINING FIRST-RATE TEACHERS -- AND IN THE AREA OF COMPUTER ASSISTED INSTRUCTION AS WELL AS IN MATH AND SCIENCE. WE DO NOT ONLY NEED COMPUTERS IN CLASSROOMS BUT TEACHERS AND STUDENTS FULLY TRAINED TO USE THEM, ESPECIALLY IN MATHEMATICAL AND SCIENTIFIC PURSUITS.

THE STATES ARE WELL AWARE OF THESE PROBLEMS, AND THOUGH ALMOST ALL ARE UNDER INTENSE BUDGETARY PRESSURES, MANY HAVE BEEN TAKING ACTION. SENATOR PELL'S STATE OF RHODE ISLAND HAS ANNOUNCED AN $8 MILLION COMPUTER INITIATIVE THAT INCLUDES FUNDS FOR TEACHER RETRAINING, AND A NUMBER OF OTHER STATE COMPUTER-TRAINING PROGRAMS ARE UNDER WAY. KENTUCKY HAS INITIATED A STUDENT LOAN-FORGIVENESS PROGRAM TO ATTRACT FUTURE SCIENCE AND MATH TEACHERS. CALIFORNIA HAS DEDICATED $19 MILLION TO RETRAINING ITS TEACHER CORPS AND TO STIMULATING STUDENTS TO PURSUE SCIENCE, MATH AND COMPUTER CAREERS. IN NEW JERSEY A SPECIAL COMMISSION REPORT ON THIS MATTER IS DUE SHORTLY, AND AT LEAST 14 OTHER STATES HAVE ON THEIR LEGISLATIVE AGENDAS PLANS TO ALLEVIATE THE SHORTAGES OF QUALIFIED MATH AND SCIENCE TEACHERS.

BUT THE DIMENSIONS OF THE PROBLEM -- AND THE CONSEQUENCES FOR OUR NATIONAL ECONOMY AND OUR NATIONAL DEFENSE -- FAR TRANSCEND THE CAPACITIES OR THE RESPONSIBILITIES OF ANY ONE STATE OR LOCAL SCHOOL SYSTEM.

THIS IS, UNQUESTIONABLY, A NATIONAL PROBLEM -- AND AN EVEN LARGER ONE THAN IS GENERALLY IMAGINED. IT MUST BE REMEMBERED THAT WE ARE NOT ONLY TALKING ABOUT THE IMMEDIATE AND URGENT NEEDS OF THE SCHOOLS. WE ARE ALSO TALKING ABOUT THE COMPETING AND URGENT NEEDS OF UNIVERSITIES, OF BUSINESS, AND OUR DEFENSE ESTABLISHMENT, BOTH MILITARY AND CIVILIAN.

IT IS NOW COMMONPLACE FOR MATH, SCIENCE AND COMPUTER TEACHERS AND PROFESSORS TO BE LURED AWAY BY BUSINESS AND INDUSTRY, AGGRAVATING THE ALREADY SEVERE PROBLEMS OF EDUCATION. FOR THIS REASON, IT IS OUR HOPE THAT ANY RETRAINING OF EXISTING TEACHERS -- AS WELL AS ANY SPECIAL BENEFITS PROVIDED TO ATTRACT NEW TEACHERS -- BE ACCOMPANIED BY A REQUIREMENT THAT THEY SPEND A SPECIFIED NUMBER OF YEARS AFTERWARD IN THE CLASSROOM. WE DO NOT WANT TO INVEST SUBSTANTIAL SUMS IN THESE INDIVIDUALS ONLY TO END UP LOSING THEM, TOO.

THE FACT WE MUST FACE, HOWEVER, IS THAT WE MUST TRAIN AND RETRAIN ENOUGH PEOPLE FOR ALL THESE SECTORS IF SUCH AN UNDERTAKING IS TO HAVE ANY SERIOUS CHANCE OF SUCCESS. IT IS ESSENTIAL, THEREFORE, TO BEGIN A LARGE FEDERAL INVESTMENT. WE RECOGNIZE THAT, IN LIGHT OF FEDERAL BUDGET RESTRAINTS, IT IS UNREALISTIC TO EXPECT THIS INVESTMENT -- WHICH ULTIMATELY WILL REQUIRE BILLIONS OF DOLLARS -- TO BE FORTHCOMING ALL AT ONCE. BUT WE CAN MAKE A SUBSTANTIAL START THIS YEAR AT THE FEDERAL LEVEL TO STRENGTHEN MATH, SCIENCE AND COMPUTER INSTRUCTION, AND I WISH TO COMMEND YOU AND YOUR COLLEAGUES, MR. CHAIRMAN, FOR LEADING THIS EFFORT.

B. CONCENTRATING RESOURCES.

GIVEN THE LIMITED AUTHORIZATION OF FUNDS PROPOSED, WE BELIEVE IT IS ESSENTIAL THAT STATES BE ABLE TO CONCENTRATE THESE RESOURCES WHERE THE NEED IS MOST SEVERE AND WHERE THEY CAN DO THE MOST GOOD. OTHERWISE, WE FEAR THAT THE FUNDS MAY BE DISSIPATED, THAT THE PROGRAM MAY MAKE LITTLE DIFFERENCE IN ATTACKING THE PROBLEM, AND THAT IT MAY BECOME NEEDLESSLY VULNERABLE TO CHARGES OF INEFFECTIVENESS.

FOR EXAMPLE, IF $100 MILLION WERE TO BE DIVIDED, ACCORDING TO STUDENT POPULATION COUNTS, AMONG ALL 16,000 SCHOOL DISTRICTS IN THE NATION, THE AVERAGE SCHOOL SYSTEM WOULD RECEIVE LITTLE MORE THAN $6,000. WE DOUBT THAT SO MODEST A SUM, EVEN WITH A MATCHING $6,000 FROM THE DISTRICT, COULD MAKE A NOTICEABLE DIFFERENCE IN, SAY, TEACHER RETRAINING, ONE OF THE MOST URGENT NEEDS.

ON THE OTHER HAND, IF STATES COULD CONCENTRATE THE RESOURCES ACCORDING TO THE MOST URGENT QUESTIONS -- WHERE ARE THE MOST CRITICAL SHORTAGES OF QUALIFIED MATH AND SCIENCE TEACHER IN THE STATE? IN WHICH AREAS DO EMPLOYERS HAVE THE MOST PRESSING NEED FOR GRADUATES TRAINED IN MATHEMATICS OR THE SCIENCES? -- WE BELIEVE THE LIMITED FUNDS WOULD BE USED TO FAR GREATER EFFECT. THIS WOULD ALSO PERMIT MUCH BETTER COORDINATION OF FEDERAL AID WITH THE REVENUES OF STATES AND LOCAL SCHOOL DISTRICTS. STATES, FOR EXAMPLE, ARE IN THE BEST POSITION TO POOL FUNDS OF TWO OR MORE SCHOOL DISTRICTS WHERE THAT MAY BE DESIRABLE.

C. SPECIAL POPULATIONS.

FINALLY, OUR CONTINUING CONCERN ABOUT SPECIAL POPULATIONS. IT IS BOTH RIGHT AND NECESSARY, WE BELIEVE, THAT DUE CONSIDERATION BE GIVEN TO THE SPECIAL NEEDS OF THE DISADVANTAGED, WOMEN, THE HANDICAPPED AND LANGUAGE-MINORITY STUDENTS. TO SHORTCHANGE THEM WOULD BE TO SHORTCHANGE ALL OF US. AMONG THEM, WE HAVE NO DOUBT, ARE A GOOD NUMBER OF TOMORROW'S FINEST MINDS IN MATHEMATICS, THE SCIENCES AND COMPUTERS, TO SAY NOTHING OF THE FOREIGN LANGUAGE AND VOCATIONAL EDUCATION AREAS. WE URGE THAT ALLOCATION OF FUNDS ENSURES THAT ALL THESE GROUPS RECEIVE THE BEST INSTRUCTION AVAILABLE.

THE STATE BOARDS OF EDUCATION, MR. CHAIRMAN, ARE EAGER TO DO THEIR PART IN THIS CRITICAL NATIONAL EFFORT, AND I WOULD CLOSE BY REMINDING YOU THAT STATES HAVE A REMARKABLE RECORD OF MEETING URGENT NATIONAL NEEDS. DURING WORLD WAR II, UNDER THE NATIONAL EMERGENCY PRODUCTION ACT, STATE DEPARTMENTS OF EDUCATION RECEIVED FUNDS FROM WASHINGTON TO TRAIN WORKERS FOR DEFENSE-RELATED INDUSTRIES. BETWEEN 1940 AND 1945, THIS ACTION PRODUCED AN ASTONSHING 7.5 MILLION SKILLED WORKERS, POPULARLY SYMBOLIZED BY "ROSIE THE RIVETER".

THE STATES STAND READY TO RESPOND AGAIN TO THIS MEASURE WHICH IS SO ESSENTIAL TO OUR NATIONAL ECONOMY AND OUR NATIONAL DEFENSE. THE NATIONAL ASSOCIATION OF STATE BOARDS OF EDUCATION IS AVAILABLE TO ASSIST YOUR ABLE STAFF IN ANY WAY WE CAN.

THANK YOU.

Attachment

1. "Classroom Crisis in Science and Math," Paul DeHart Hurd, Professor of Education, Stanford University, Chemical and Engineering News, July 19, 1982.

> Currently, for example, only 34% of U.S. high school graduates have completed three years of mathematics; only 8% have taken calculus, which is taught in only 31% of U.S. high schools. Fewer than 20% of the graduates have had three years of science. Most seniors have had a course in biology, but only 19% have had physics.

2. "Classroom Crisis in Science and Math," Sarah E. Klein, retiring president of the National Science Teachers Association, Chemical and Engineering News, July 19, 1982.

> She cited a 1981 survey of state science supervisors by Trevor Howe and Jack Gerlovich of the University of Iowa Science Education Center. That survey, based on the response from 43 states, disclosed a 'critical shortage' of chemistry teachers in 10 states and a 'shortage' in 27. For physics and math teachers the situation was even worse.

3. "Math, Science Teachers are in Short Supply; One Solution: Money," National Science Teachers Association, The Wall Street Journal, December 21, 1982.

> According to the National Science Teachers Association, 43 states reported shortages of math teachers, 42 were short of physics teachers and 25% of the math and science teachers surveyed by the association said they were planning to leave teaching for better paying jobs in industry.

4. Education USA, January 10, 1983, report from the National Academy of Science/National Academy of Engineering.

> The academic preparation of science and math teachers typically does not include the courses they need to do a good job of teaching in high school. University science departments and schools of education must recognize their responsibility in reforming teacher education.

5. Education USA, January 10, 1983, report from the National Science Foundation.

> - Most teachers are dissatified with community attitudes, treatment of education by the media, student attitudes toward learning and status.

- About 67% of the teachers said they needed help in getting information about new instructional materials, but only half received any assistance. Maintenance of equipment was the most frequently cited (60%) need.

- Availability of lab assistants or paraprofessionals and money to buy supplies were seen as major needs.

- Math teachers said the lack of materials for individualizing instruction was their largest problem.

- Science teachers perceived three serious problems: inadequate facilities, not enough funds to buy equipment and supplies, and a scarcity of materials for individualizing instruction.

- Only 22% of elementary school teachers feel "very well qualified" to teach science, and 16% feel "not well qualified." Sixty percent feel "adequately qualified."

6. American Federation of Teachers Preliminary Report on the Math/Science Teacher Shortage.

> The number of newly issued certificates being issued in New York State are going down dramatically. For example, between 1975 and 1979, the number of newly issued certificates declined by the following percentages: Math-69%, Biology-43%, Chemistry-54%, Physics-50%, and Earth Sciences-49%.

7. A Summary Report on the Educational Systems of the United States and the Soviet Union: Comparative Analysis, Catherine P. Ailes, Francis W. Rushing, National Science Foundation, February, 1982.

> Science and the development of critical thinking skills in social studies and math have assumed a low priority in the thinking of school administrators. An increased emphasis on the basic learning skills, such as reading, arithmatic, and spelling, is preempting time previously available for the study of science, social studies, and mathematical concepts, especially in elementary schools. The NSF case studies observers found that in most schools natural sciences, mathematics, and social science inquiry were seen as having a rather limited value for the student body at large, and that providing a strong K-12 program in science for those students who will become the nation's future scientists was not a high priority in most of the school systems.

8. Mathematics Teacher, March 1981.

More than 5,000 of the school's districts have "no certified math or science teacher at a time when we are emphasizing those subjects." The same article reports that Dallas had 150 current vacancies, most of which were in math, science, industrial arts, and special education at the secondary level.

9. The State of School Science. The National Research Council, June 1979.

The Soviet secondary school curriculum is quite accelerated in science and math as compared to U.S. high schools. The entire school population is exposed to the math-science oriented curiculum in Soviet secondary schools rather than only selected students as is the case in the United States. Thus, in general, the Soviet secondary school graduate has a far better training in math and science than does his U.S. counterpart.

10. Education for a High Technology Economy, Material prepared for National Governors' Annual Meeting, August 8-10, 1982, by the Education Commission of the States.

- Between 1960 and 1977, the proportion of public high school students enrolled in science and mathematics courses declined; the number of students enrolled in science declined from 60 to 48 percent.
- Despite recent increases in mathematics and computer science enrollments, one half of all high school graduates in the U.S. take no mathematics or science beyond the tenth grade.
- Mathematics and science achievement, as measured by successive national assessments throughout the 1970's have shown a steady decline. This decline has been least for 9 and 13-year-old age groups with increasing deficits for 17-year-olds.
- The effect of insufficient quality of mathematics and science preparation in the elementary and secondary schools is revealed by the fact that remedial mathematics enrollments at 4 year institutions of higher education increased 72 percent between 1975 and 1980 — compared to a 7 percent increase in total student enrollments for the same period.
- Scores on the Scholastic Aptitude Test (SAT) for approximately one million college-bound students have declined over an 18-year period through 1980. The mean score in mathematics dropped from 502 in 1963 to 466 in 1980.

11. Education for A High Technology Economy, material prepared for the National Governors' Annual Meeting August 8-10, 1982, by the Education Commission of the States. Material cites a deficiency in the math and science areas due to lack of educational goals among various state education agencies and negative attitudes of students. This is highlighted by the following data:

- Admission requirements for postsecondary institutions have generally reduced the number of years of pre-college mathematics and science instruction.

- By the end of the third grade, nearly 50 percent of students would like to take more science; by the eighth grade, only 20 percent have a positive attitude toward science.

- Time devoted to academic activities is closely correlated with achievement. The typical school year in the United States is 180 days, with students attending 5 1/2 to 6 hours each day. The average number of days of school attendance is 161 because of absenteeism. This compares with a 240-day school year with 6 to 8 hours per day, in the USSR, China, East Germany, and Japan where absence from school is minimal.

- Students who report doing the most homework scored higher on the national assessment in mathematics; those students who report not doing homework and watching television scored lower in mathematics.

- Although 21 states have established or are considering mandates for computer literacy and the application of technology for improving instruction, the barriers of the cost of hardware procurement, the cost and lack of availability of quality courseware and the lack of trained teachers makes the implementation of this goal a long-term, difficult process.

12. Sarah E. Klein, President of the National Science Teachers Association, Testimony before the Senate Committee on Labor and Human Resources, 1982.

- Only 55% of the graduates prepared to teach mathematics actually entered the teaching profession. Almost five times more science and mathematics teachers left teaching in 1980 for employment in nonteaching jobs than left due to retirement. If the present exodus of qualified science and mathematics teachers from secondary schools continues, the nation will have a net loss of 35% by 1992. The declines in qualified science and mathematics teachers have already exceeded enrollment declines by a factor of three.

13. Ronald Reagan, at the Convocation of the National Academy of Science and the National Academy of Engineering, May 1982, was quoted by the National Council of Teachers of Mathematics Fact Sheet:

> The problems today in elementary and secondary school science and mathematics education are serious enough to compromise America's future ability to develop and advance our traditional industrial base to compete in international marketplaces. Failure to remain at the industrial forefront results in direct harm to our American economy and standard of living.

14. Education Week, 31 March 1982:

> Since 1972 there has been a 77 percent decline in the number of secondary level mathematics teachers prepared in 600 teacher-training programs nationwide. Among newly employed science and mathematics teachers, 50.2 percent were judged by principals to be unqualified to teach in those fields, but had been employed on an emergency basis because school officials could not find qualified teachers. In the Pacific states, the ratings of unqualified personnel jumps to 84% by the principals.

15. "New Study Shows Decline in Math, Science Levels," Detroit, Michigan News, November 14, 1982, quote by Fletcher Byron, Chairman of the Board of Trustees of the Committee for Economic Development:

> While the need for scientific and technical skills is growing, many studies now indicate the general level of scientific knowledge in this country is at an all time low.

16. U.S. News and World Report, 15 February 1982.

> Alleviating the math-teacher shortage is one of the most immediate and pressing tasks facing colleges and school systems.

17. National Science Teachers Association, 1981.

> The quality of science and mathematics instruction is deteriorating further as a result of budget cuts. Sixty percent of science teachers have had their budgets for supplies and equipment cut, at a time when school labs are already obsolete and when computers and other modern electronics are essential to an up-to-date curriculum.

18. Education for a High Technology Economy, Material Prepared for the National Governors' Association Meeting, August 8-10, 1982 by the Education Commision of the States:

- In the period 1971-1980, a survey of 600 colleges and universities with teacher training programs revealed that there was a 64 percent decline in the number of secondary school science teachers being prepared and a 78 percent drop for mathematics teachers.
- Twenty-six percent of all mathematics positions are filled by teachers who are not certified, or are only temporarily certified, to teach mathematics. This pool appears to be expanding, for among the newly-employed secondary mathematics and science teachers, 50 percent are uncertified to teach science or mathematics.
- Of elementary school teachers, 51 percent report they received no undergraduate training in science.
- Not only is there a shortage of qualified science and mathematics teachers, there is also a shortage of summer institute and college programs to educate them. The extensive programs of the National Science Foundation during the 1960's for the retraining of teachers after college no longer exists.
- The average salary of beginning mathematics teachers with a bachelor's degree is now only 60 percent of the beginning salary offered by private industry to bachelor degree candidates in mathematics and statistics.
- High school seniors specifically bound for teacher education programs scored, on the average, 48 points below the national average in mathematics skills and 35 points below in verbal skills on the Scholastic Aptitude Test (SAT).

Senator PELL. Thank you very much indeed.

Dr. Smith?

Dr. SMITH. Senator Pell, I am reporting on behalf of the Council for American Private Education, which represents about 80 percent of America's private schools. We employ about 281,000 teachers.

We want to say first that we strongly endorse the Federal efforts to alleviate these problems in math and science, but we would also ask that the Senate keep in mind that there is also a crisis in illiteracy which is also serious, and a crisis in reading and writing. So, we have got to keep all these matters in balance.

Our testimony will be divided into three parts: what we think can be done immediately, or should be done; what we think can be done over a longer period; and then some matters which refer directly to private schools.

First of all, we support the legislation to finance summer institutes to upgrade teachers in their knowledge and skills. We would also hope that those institutes would attract other people who are not now in teaching.

Two, we strongly support legislation to grant scholarships to teachers who want to augment their knowledge and skills for math and science teaching. We would also hope that these kinds of scholarships would be such that they would attract new recruits into the world of math and science teaching.

We strongly support legislation through incentive grants which encourage cooperation between school districts, industry, and other community resources, including private schools, because not only will this help to solve the math and science problem, but as these groups get to work together, we think they will help to solve other major problems of education in communities.

Another idea which we recommend is that Congress consider the possibility of approving a voluntary national service period for students during a year between high school graduation and college graduation, so that some of them could become math and science teachers.

There, of course, would have to be a process for selecting and training these teachers, but we think that the supply of able, young instructors produced in such a program would go a long way to alleviating the problem. Another added benefit would be that this would induce a lot of able people to go into teaching as a career.

Another no-cost, high-yield prescription which we would suggest of immediate usefulness is to greatly increase the incidence of using students to teach other students; in other words, peer teaching in math and science. If only six well-chosen students in every school in the country were used to help teach math and science to their fellow students, we could augment the math/science teacher force by over 100 percent. Again, as within the previous suggestion, once a teacher, always a potential teacher, and obviously we need good teachers.

Because a significant pool of potential math/science teaching talent exists among senior citizens who have retired from math and science-related careers, we urge that incentives be established for utilizing their services, as well as people who are currently unemployed and in related fields, like bookkeepers, economists, and so on.

On a long-term basis, we strongly support the provisions of the McCurdy and the Glenn bills, which attempt to stimulate an infusion of new teachers by providing low-cost loans to college students pursuing math- and science-teaching careers—loans in which payment is forgiven at the rate of 25 percent a year.

Also, as a no-cost and long-term solution to this problem, we hope that all teachers will begin to encourage girls at all levels to think of themselves as potential math/science teachers, and think of math/science careers, because part of this problem is a gender gap problem.

Of particular concern to private education, we are pleased that almost all the legislation that has been proposed includes the equitable treatment of all teachers and potential teachers in institutions, for private schools are heavily involved in the circumstances which impel these initiatives.

Many of our teachers need retraining. We have a shortage of math/science teachers. Many of our schools cannot afford the hardware, and so on.

Some legislative proposals have limited teacher eligibility to certified teachers. Private schools uniformly employ well-qualified teachers, so we hope that you will use the term qualified rather than certified.

Finally we hope that you will assume that any legislation approved by this committee will incorporate the necessary provisions to insure fair and equitable participation by the private-school sector. We recommend basic ECIA chapter II provisions incorporated in the House bill.

Thank you very much, Mr. Chairman.

[The prepared statement of Dr. Smith follows:]

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Robert L. Smith
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MATH - SCIENCE TESTIMONY

This testimony is presented on behalf of the Council for American Private Education (CAPE) which, through its fifteen member organizations, represents approximately 80% of the nation's private schools, enrolling just over 4 million students. Private schools employ 281,150 teachers, about 11.5% of the nation's teaching force.

CAPE strongly endorses federal efforts to help alleviate the well documented national problems involving math-science education, problems which, in the aggregate, clearly represent a crisis for education, economics and national survival. We would add, not to divert but to help put into perspective the considerations of this Committee, that our nation is faced with a serious crisis in the learning of all the basic subjects, including reading and writing. A high level of illiteracy will doom our democracy and our standing as a world power as surely as will widepread ignorance of math and science. So let's not let preoccupation with one important area of serious educational decline prevent us from being attentive to and supportive of the state of learning of all the essential school subjects.

Members. The American Lutheran Church • American Montessori Society • The Association of Evangelical Lutheran Churches • Association of Military Colleges and Schools of the U.S. • Christian Schools International • Friends Council on Education • Lutheran Church — Missouri Synod • National Association of Episcopal Schools • National Association of Independent Schools • National Association of Private Schools for Exceptional Children • National Catholic Educational Association • National Society for Hebrew Day Schools • Seventh-day Adventist Board of Education, K-12 • Solomon Schechter Day School Association • U.S. Catholic Conference. Associated state organizations in Arizona, California, Connecticut, District of Columbia, Florida, Georgia, Indiana, Kansas, Maryland, Michigan, Minnesota, Missouri, Montana, Nebraska, New Mexico, Oregon, Puerto Rico, Rhode Island, Tennessee, Texas, Virginia, Washington, and Wisconsin.

The highly sobering facts about the critical shortage of math and science teachers, the disturbing weakness of an alarming majority of students in math and science, the critical needs of our evolving society of educating students to be technologically literate and scientifically and mathematically competent, all speak to giving a very high national priority to attacking, on every front possible and at every level of education, the problems giving rise to this crisis.

Because the many gloomy facts about the situation are so readily available, I won't waste the Committee's time repeating them here. But I would suggest that we keep ever in mind the underlying irony of our present circumstances: that the mightiest industrial, technological country on earth is in grave danger of losing its preeminence because of its gross neglect of the first principal of even the poorest of nations -- to bring up its youth in the knowledge and skills necessary for national survival.

This testimony will be divided into three parts. The first contains suggestions with immediate applicability -- what we can do now or relatively quickly. Second are suggestions which will take time to implement or to bear fruit. Within both categories are prescriptions which require no legislation or federal funds. The third section focuses on several matters specific to private schools which we respectfully urge be kept in mind by the Committee in fashioning Math-Science Legislation.

First - now and in the immediate future.

1. We strongly support the legislation to finance summer institutes to upgrade

knowledge and skills of currently employed teachers of math and science. We would also urge that such instititutes be available to potential math-science teachers — i.e. teachers in other fields or those who, from the experience of other careers, wish to do teaching in math and/or science. Essentially, we urge that broad flexibility be provided to carry on institutes most appropriate to the people involved. We have seen the value of teacher training institutes involving teachers from different kinds of institutions, public, private and higher education and the mutual enrichment which they can provide. Thus, we would emphasize the importance of encouraging wide variation in the forms these institutes may take.

2. We strongly support the provision in HR 1310 to grant scholarships to teachers who want to augment their knowledge and skills for math-science teaching. We would urge that the availability of these scholarships be widely known and their use broadly encouraged toward the end that 'new recruits' may be brought into the ranks of math-science teachers. If the Senate feels it is necessary to put some restrictions on the kinds of institutions at which these scholarships may be used, we would strongly urge that preference be given to those institutions which can provide strong programs in subject matter learning.

3. We support the provision of HR 1310 which, through incentive grants, encourage cooperation between school districts, industry and other community resources including private schools. Cooperative arrangements which bring the energies and support of all segments of a community having a stake in the improvement of math-science education are critical. The creation of technology centers in communities to help make both students and adults technologically literate,

the use of industry personnel in classrooms or in in-service programs, the loaning or giving of equipment together with many other useful, often highly innovative 'home-grown' efforts can be of enormous value. Not only do they directly serve math-science education. They mobilize the resources of a community concerned with education toward working together to help solve other educational problems.

4. I recommend that the Congress consider the possibility of approving a voluntary National Service period for students during a year between high school graduation and college graduation during which incentives could be provided for those who devote their time to math-science teaching. There, of course, would have to be a process for selecting and training student teachers. However, the supply of able young instructors produced in such a program would go a great distance toward alleviating the math-science teacher shortage. Equally important, some of our most able students might be induced to make teaching a career.

5. We recommend, as a no-cost, high yield prescription of immediate usefulness, greatly increasing the incidence of using students to teach students - peer teaching - in math and science. As everyone knows, students learn by teaching and students often learn best be being taught by a peer. If only 6 well-chosen students in every school in the country were used to help teach math and science to their fellow students, we could increase the nation's teaching force by approximately 20%. And we could augment the math-science teacher force by over 100%. The same rule applies for in-school students teachers as for National Service student teachers: once a teacher, always a potential teacher.

6. Because a significant pool of potential math-science teaching talent exists among senior citizens who have retired from math-science related careers or who are otherwise equipped to teach in our schools, we would urge that incentives be established for utilizing their services. Among these might be waiving state teacher credentialing requirements and increasing the amount of money above social security which they could earn under favorable tax conditions. The incredibly well-organized ranks of senior citizens could be effectively, if selectively, mobilized to take part in this national effort, if properly approached and reasonably reimbursed. Similarly, people who are currently unemployed and in related fields (bookkeepers, economists, etc.) should be included in scholarship, loan and other incentive programs to help bring them into math-science teaching. (Of the Ph.D. graduates in engineering last year, 1,700 are currently unemployed.)

Second - the long term

1. We strongly support the provisions of the McCurdy and Glenn bills which attempt to stimulate an infusion of new teachers into math and science teaching by providing low cost loans to college students pursuing math-science degrees for which payment is forgiven at the rate of 25% per year of teaching in elementary or secondary school. Because the effect of this provision will take many years to bear fruit, we urge that the Committee acknowledge the importance of this factor in its handling of the legislation. I would point out one flaw, from the private school standpoint in Senator Glenn's bill. It forbids industry personnel from in-service activity in a denominational private school - a provision which seems unnecessary, unreasonable and of serious consequences in over 4 out of 5 private schools.

2. A non-legislative, no-cost prescription is that all teachers, and not just those teaching math and science, encourage at every grade level and in every way possible, growing girls to not only perceive themselves as just as able to do math and science as growing boys, but to consider these fields in their career plans. At least part of the teacher gap in math and science is a serious gender gap. Closely related, and strongly to be encouraged, are current collegiate efforts, Barnard College comes to mind, to prescribe numerical literacy as necessary to the education of all college students.

Third - particular concerns of private education about math-science legislation:

1. We are very pleased that almost all the legislation that has been proposed includes the equitable treatment of all teachers and potential teachers and institutions, for private schools are inextricably involved in the circumstances which impel these legislative initiatives. We are experiencing a shortage of math-science teachers (our major teacher recruitment agencies report a ratio of jobs to applicants of 5 to 1 for math teachers and 2½ to 1 for science teachers). Many of our teachers needs retraining and/or opportunities to further their knowledge and skills. Many of our schools can't afford the hardware and materials necessary to keep current in science and technology.

2. Some legislative proposals have limited teacher eligiblity to "certified teachers". Private schools uniformly employ well qualified teachers. However, the use of the term "certified" if interpreted to mean state certified, would disqualify a great number of private school teachers who are not required to be state certified in order to teach. The private school teacher must be

qualified because those who pay his salary, the school and the school parents, must insist on his competence.

3. We would urge you to include strong and clear language requiring equitable participation of administrators and teachers from private schools at every stage of community cooperative efforts.

4. And finally, we assume that any legislation approved by this Committee will incorporate the necessary provisions to ensure fair and equitable participation by the private school sector. We specifically recommend the basic ECIA Chapter II provisions, as incorporated in the House passed bill, as a good model.

Once again, Mr. Chairman, we thank you for this opportunity to testify on this critical national concern. We hope our testimony will be useful.

Robert L. Smith
Executive Director

Senator **Pell**. Thank you very much, Dr. Smith.

Now, we have Dr. Joan Parent, first vice president of the National School Boards Association.

Dr. **Parent**. My name is Joan Parent. I am first vice president of the National School Boards Association, and a member of the National Science Board's Commission on Pre-College Education in Math, Science and Technology.

I would like to summarize by saying there is a critical need to upgrade the quality and scope of elementary and secondary course offerings in math, science, foreign languages, and technology. This demand springs from a national recognition that education is at the core of our Nation's future economic success, its defense and its international position, both politically and economically.

Yet, across the United States, school districts do not have the capacity to deliver at the level now being demanded. When a result of a decade-long, lowered, national priority for education by all levels of government is coupled with the negative impact which current economic conditions have had on State and local revenue capacity, an immediate, broad-based response by those levels of government will be haphazard at best.

Clearly, the stage is set for a major policy initiative at the Federal level. In crafting legislation, we urge the committee to deal with two main points. First, the scope of activity should be broad, clearly defined, and supported by adequate funding.

Second, the legislation should recognize those activities that are best performed by each level of government and include the necessary safeguards to insure that happening.

NSBA is supporting the National Education Economic Development Act, called the NEED bill, which we believe offers the best delivery system from the standpoint of local school boards.

The ingredients of the bill which we find attractive are as follows. First, at $1 billion, the funding level is responsible. In our view, anything less than that for elementary and secondary education will promise more than it can deliver.

Second, because 85 percent of the funds will flow to local school districts on a local formula basis, local control and flexibility will be retained. Grantsmanship, bureaucracy, and paperwork will be minimized, as distinguished from project grants.

Third, in describing the kinds of activities to be funded at the local level, it defines the scope of the solution by including funding for inservice training of teachers in math and science; inservice training of teachers in the use of computers as instructional aids; school district planning, and this is particularly important because the pressure is on local school boards and administrators to spend vast sums of money on hardware, software, lab equipment, more teachers, new textbooks, and other modernized classroom materials; and a variety of innovative techniques which utilize the resources of business, libraries, museums, universities, and peer review by other local school districts.

Fourth, the role at the State level is recognized by including such features as information on manpower trends; the evaluation of hardware and software programs; technical assistance for local planning and in-service training; the forging of new relationships between the public school community and businesses, libraries, museums, et cetera; improved standards and certification requirements for teachers; the funding of basic and applied research; and making grants to local school districts for innovation and special needs.

Fifth, we believe there should be proper recognition of the Federal role. We believe this is particularly important because most bills have overlooked the importance of the Federal role. To a great measure, the Federal Government should do at the national level what we hope the States will be doing at their level.

The Federal Government should make grants and contracts with universities and other appropriate educational agencies for the development and evaluation of curriculum models, instructional approaches, and program innovations.

Senator, I would ask that my written testimony be included in the record, and I would be happy to answer any questions I am able to.

[The prepared statement of Dr. Parent follows:]

NSBA
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TESTIMONY

on behalf of the

NATIONAL SCHOOL BOARDS ASSOCIATION

on
THE EDUCATION FOR ECONOMIC SECURITY ACT,
THE NATIONAL EDUCATION AND ECONOMIC DEVELOPMENT ACT (NEED 8111),
AND RELATED MATH AND SCIENCE LEGISLATION

before the

SENATE EDUCATION, ARTS, AND HUMANITIES SUBCOMMITTEE
430 Dirksen Senate Office Building

March 8, 1983

Presented by
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1st Vice President, NSBA

Also present for NSBA:

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serving American education through school board leadership

A. Introduction

My name is Dr. Joan Parent and I am First Vice President of the National School Boards Association (NSBA) and a member of the National Science Foundation's Commission on Pre-College Education in Mathematics, Science and Technology. NSBA is the only major education organization representing local school board members. Throughout the nation, approximately 90,000 of these individuals, through their state organizations, are association members. They are responsible for the education of more than ninety-five percent of the nation's public school children.

Currently marking its forty-second year of service, NSBA is a federation of state school boards associations with direct local school board affiliates, constituted to strengthen local lay control of education and to work for the improvement of education. Most school board members are elected public officials. Accordingly, they are politically accountable to their constituents for both education policy and fiscal management. As lay, unsalaried individuals, school board members are in the rather unique position of being able to judge legislative programs purely from the standpoint of public education, without consideration to their personal professional interests.

NSBA believes that a major legislative initiative in mathematics, science, foreign languages, and technology should be a top legislative priority in the 98th Congress. We are pleased that a number of bills have been introduced, including the NSBA sponsored National Education and Economic Development Act (the NEED bill of 1983 -- H.R. 659/Senate introduction pending.)

B. Scope of the Problem

At the outset, I want to thank the Committee for this opportunity to testify on the issue of mathematics, science, and foreign language in education. Additionally, I would like to commend the Chairman and members of the committee for introducing various legislative proposals -- thereby focusing attention on solutions, rather than simply dwelling on the problem.

Over the past two years, our national leaders, including members of Congress, have recognized the connection between the current technological boom and the nation's future economic growth, its security, and its international position. In turn, you have recognized that the education of today's youth is at the core of that technological society which we envision for America's future prosperity.

Public debate, including recent action on the floor of the U.S. House of Representatives, has produced a barrage of facts and statistics which do not require repetition today. What is important are the conclusions which this data reveals about the capacity of the nation's 16,000 school districts to educate a more mathematically, scientifically, and internationally directed citizenry.

- In the area of teaching, we know that --
  - Fewer schools of education are graduating students who are seeking to teach math and science. Indeed, some states can count on one hand the number of college graduates who will be entering teaching in the various math and science disciplines.
  - School systems can only compensate starting math and science teachers at about 60% of industry base pay levels. Accordingly, more existing teachers are leaving the field for more lucrative jobs in the private sector.
  - Teachers are not sufficiently familiar with computers so as to use them as effective instructional tools within the context of an overall educational program.
  - At the elementary level, many teachers do not have the subject knowledge and instructional skills that are needed for more effective teaching in mathematics.

  - At the secondary level, about one-half of all new teachers in mathematics and science are being hired under emergency certification. That is, they are not fully qualified to teach their subjects.[1]

- In the area of student performance, we know that --

  - Student achievement scores in mathematics have fallen over the past twenty years.

  - One-half of all high school students do not take math and science after their second year (thereby decreasing the scope of course offerings that school systems are now budgeted to provide). This reflects a long-term decline in student interest in mathematics, science and foreign language courses.

- In the area of school district management, we know that --

  - Administrators and school boards need assistance for planning and evaluating the costly hardware and software proposals, and other curriculum and instructional innovations, which they are considering for their school systems.

  - Curriculum has to be modernized and expanded, which means costly expenditures for textbooks and laboratory equipment, in addition to their expenditures for the new technologies.

  - School systems need to have a better understanding of the changing academic base required by employers, as well as employment trends, and the changing nature of work.

C. A National Solution: An Increased Financial Commitment to Education At All Levels

In identifying the scope of the problem, the above depiction should not be construed as a failure by the nation's school systems. Rather, the above conclusions reflect a sudden demand for more educational product on the one hand -- following a decade-long decline in the nation's educational priority, on the other.

In essence, a nationwide commitment to 16,000 local school districts and the 40 million children which they serve will cost billions of dollars. These funds will have to be spent for such activities as in-service training, the establishment of compensation packages which can attract and retain qualified personnel, the expansion of course offerings, purchasing up-to-date laboratory and instructional equipment plus instructional materials, and implementing new approaches to operating school systems -- including arrangements with business, libraries, museums, and other local school systems. Simple solutions to the problem, such as raising college admissions standards may help, but they cannot be taken as a sole or primary solution.

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[1] This reflects the lack of available new teachers in the field as well as teachers within the system seeking to transfer disciplines.

Each level of government will have to participate if the nation is going to respond to its educational needs. In this regard, NSBA believes that there is a definable federal role to provide funding and leadership. I would like to briefly highlight that role and provide an outline for what local school boards find to be the best approach for delivering federal assistance.

D. Federal Role in Mathematics, Science, Foreign Language, and Technology Education[2]

The federal role in this arena should be directed toward several purposes:

- to stimulate comprehensive planning by local school districts -- including making available to them information about successful programs, the market place, and evaluations of instructional innovation;
- to develop capacity building activities within school systems, particularly in the areas of in-service training and curriculum improvement;
- to inspire innovation in programming, new relationships with other sectors, and the use of new technologies;
- to assist in financing such classroom maintenance costs as hardware/software purchases, laboratory equipment, other classroom materials and employee compensation;

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2) Because our statement deals with the federal role as it would directly assist local school districts, we will not be making specific redommendations in higher education. However, we support bills that would strengthen teacher education programs, financial aid inducements for students to enter teaching, and continued research for more effective teaching in math, science, foreign languages, and technology.

- to foster an ongoing evaluation of whether a school system is achieving its goals and priorities; and
- to underwrite a state and federal leadership/coordinating role in such areas as market trends, innovation, and research.

E. Structure of A Federal Program

In order to meet the foregoing purposes, a federal program should be structured as follows:

- For local school districts --
  - National Program. Since education occurs in all 16,000 local school systems, funding should be available to each eligible school system.[3] In this regard, while demonstration and project grants are important components to a major effort (such as those provided under S. 530), they are not the sole answer for the thousands of school systems that can't afford to replicate the successes of neighboring districts.
  - A Locally Based Program. While it is one matter to fund 16,000 local school districts, it's quite another to provide them with the flexibility to design programs in a manner which reflects local needs and priorities. Perhaps the case for flexibility is best made by example. If a school district wants to expand its emphasis on physics, how it accomplishes that result can vary. For example, a school system located in a college town may not have a shortage of physics teachers but can profit from connecting computers to the college library. In the meantime, a surburban school district may want to use the

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3) In urging participaton by all school districts and by urging the use of a local student count formula, depending on the amount of federal funds available, such federal formula factors as school district need ought to be taken into account.

professional in-servicing expertise that can be made available by local scientific companies, whereas a rural school system may want to teach physics through interactive cable television. The best way of guaranteeing local control is to distribute funds on a local student count basis[3] with minimum state and federal review.

In urging local flexibility in program design, a federal program also should require appropriate accountability. In balancing these two factors, NSBA suggests that local school districts be required to adhere to fiscal audit requirements and to have their plans subject to a state review and comment process. In this latter regard, especially since the federal program is dealing with basic instructional programs, we believe that it is inappropriate for the federal government to require states to actually approve the curriculum and instructional approaches being developed at the local level. Rather, the federally imposed state role should be advisory, which might include informing the local school district that in using federal funds, it is responsible for complying with any state developed policies and standards.[4]

●● A Comprehensive Program. Just as there must be flexibility in determining how a particular activity should be served, the range of activities available to a local system should be broadly defined. In this regard, the best programs will not be designed if Congress legislates a series of piecemeal programs that may or may not address the precise categorical needs of particular school systems -- or whose success depends upon the "packaging" skills of local grant writers.

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4) If existing state practice in any way regulates these factors, local school districts will continue to be subject to those requirements. The point is, the federal government should not be telling states to regulate or not to regulate, local curriculum or instructional approaches.

Indeed, to date Congress has not addressed educational needs of true national significance on a piecemeal basis. For example, in serving the needs of disadvantaged and handicapped students, the federal role (under Chapter I and P.L. 94-142) does not require school districts to develop a separate, single-purpose grant for each aspect of educating those children -- such as in-service training, equipment, or special textbooks. Fragmenting local program development in this way would be a mistake. Ideally, the improvement of mathematics and science should be placed on the same footing; that is, there should be one comprehensive maintenance program rather than separate grant programs for computers, in-service training, and so on.

•• A Maintenance and Capacity Building Program. Local school districts require more than a "quick fix." We have a broad range of systemic needs which will require long term assistance. For example, funds are needed for capacity building purposes, e.g., planning, in-service training, and curriculum development. In essence, by capacity building, I am referring to a use of funds which strengthens the resources that are put into the classroom. Likewise, funds are needed for maintenance purposes, such as the acquisition of hardware, software, laboratory equipment, textbooks, and increased teacher salaries. That is, maintenance expenditures would enable a use of funds to help underwrite the costs of operating the classroom.

- Adequate Funding

None of the above-mentioned program components can operate without adequate long-term funding. NSBA believes that the cost of financing a true national program will require at least $1 billion annually of federal funding. This translates out to about $25 per pupil or $25,000 for a school system having an enrollment of 1,000 students.

We believe that any program which is funded at a lower level will not result in a comprehensive treatment of the issue -- and unless its purposes are significantly narrowed down, will promise far more than it can deliver.

- The State Role

Local school districts should not operate in isolation. Among the services that federal funds could help states to provide would be: information on manpower trends, the evaluation of hardware/software programs, technical assistance for local planning and in-service training, the forging of new relationships between the public school community and businesses, libraries, museums, etc., improved standards and certification requirements for teachers, the funding of basic and applied research, and making grants to local school districts for innovation and special needs.

- The Federal Role

To a great measure, the federal government should do at the national level what we hope states will be doing at their level.

First, the federal government should make innovative grants to those local school districts which can offer promising ideas. Likewise, grants should be available for targeted needs such as districts in sparsely populated areas or those with high concentrations of disadvantaged students.

Second, the federal role should develop a dialogue, perhaps through a national council, which brings education together with industries of national scope as well as the major departments of government which have an interest in economic productivity and defense. Through this national dialogue a solid connection could be formed between education the emerging needs of our national market place.

Third, the federal government should make grants and contracts with universities and other appropriate educational agencies for the development and evaluation of curriculum models, instructional approaches, and program innovations -- including the technologies.

Fourth, the federal government should collect data and report on the condition of education in mathematics, science, foreign languages, and technology -- including trends in student achievement as well as the measures of improved teaching (e.g., certification, compensation, and numbers of teachers in the field).

F. The National Education and Economic Development Act (the NEED Bill) As A Federal Approach

Given the purposes which should be served by the federal level, and given the structural ingredients which I have just described, NSBA believes that the National Education and Economic Defelopment Act, that is, the NEED bill (H.R. 659 in the House/Senate introduction pending) presents a compelling solution. A summary of the NEED bill has been appended to our statement.

G. Policy Misdirection: a) not a professional manpower issue, b) project grants not a satisfactory response

At this point, I would like to discuss a number of policy misdirections which have been proposed in connection with the math, science, foreign language, and technology issue.

- Not a professional manpower issue

Some observers have suggested that broad nationwide strategies in this area reflect an overreaction to future manpower needs. These observers argue that except for increasing the need for relatively few scientists and engineers, the new techologies will simplify the nature of work. As a result, it is alleged that the general workforce will not need more exposure to math and science. Therefore, it is argued that the federal effort which is now being undertaken, should be focused on the narrower academic needs at the postsecondary level for the purpose of training scientists and engineers.

While there definitely is a professional manpower need, NSBA believes the foregoing observations miss the main point for several reasons:

- First, since student interest in mathematics begins to wane as early as the third grade, any effort to increase the number of scientists and engineers must begin at the elementary level with continued academic support throughout the secondary schools. The point is, college-bound students do not decide to become engineers or scientists unless their skills and interest are developed in grade school.
- Second, future workers in a technologically-based society will be holding more jobs during the course of their lifetimes. As a result, they should have a broad background in the principles of math and science, in order to facilitate their adult skill training as they move from job to job. Further, to the extent we revere the Japanese management model, consistency would suggest that American workers be more than "button pushers" and be a part of a management concept which

allows ideas to rise from the "bottom up." This will require an adequate education for employees at all levels.

•• Third, while one main purpose of education is to prepare our youth for the world of work, the educational process should also develop a citizenry which can make decisions and thrive happily in our society. If the American scene is becoming more technological, our people will need to be prepared for it -- even if their work environment is simplified.

• Project grants not a satisfactory solution

A number of bills have been introduced which envision $100-$200 million of project grant funding for local school systems. While project grants are a valuable resource, and they do form a part of the program envisioned by the NEED bill, we believe that such a concept falls far short as a total federal solution. Thousands of school districts would like to replicate the efforts of neighboring districts but can't because of the lack of funds.

NSBA was disappointed that the House failed to recognize the full implications of the federal role when it developed H.R. 1699. That bill would provide only $250 million for elementary and secondary education. The strength of that bill, however, is that after stipulating a low authorization, it establishes priorities -- in which all local school districts can participate on a local formula basis.

H. Conclusion

The relationship between technology and economic growth, national security, and international competition is obvious. The reliance of technology upon education is equally clear. Both the educational base and interest of our students in math, science, and foreign languages must be formed at the elementary and secondary levels. Unfortunately, a lowered national priority on education has resulted in a major educational shortfall in student performance as well as in such vital resource ingredients as sufficient numbers of qualified teachers, up-to-date technology, equipment, and classroom materials. Due to the condition of educational funding, the establishment of new programs from state and local resources will be difficult and haphazard.

There is a role for the federal government to provide assistance to help school districts in the development of plans, to develop their resource capacity, to maintain the cost of their classroom operations, and to assess their programs. A federal program of this kind will cost at least $1 billion annually and must consist of local formula grants plus a strong resource role for the state and federal levels.

We believe the NEED bill provides such a program. In contrast, a program of state project grants would not be adequate because of limited funding and the inability of such a program to reach all school systems.

In considering the federal role, a broad view of education should be taken, rather than the specific or immediate manpower needs in particular industries. If the committee decides to follow the House in establishing a limited federal role for elementary and secondary education in the $250 million range, we strongly advise a program of local formula grants, with a targeting factor for districts with special needs and a use of funds which establishes priorities starting with management/policy planning and the in-service training of existing elementary and secondary teachers.

On behalf of the National School Boards Association, I wish to thank the committee for this opportunity to testify.

Senator Pell. I thank you very much indeed. The written statements of all of you will be included in the record as if read.

[Additional material supplied for the record follows:]

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An Affiliate of the American
Association for the
Advancement of Science

March 14, 1983

Robert T. Stafford, Chairman
Subcommittee on Education, Arts,
and Humanities
U.S. Senate
309D Senate Courts
Washington, DC 20510

Dear Senator Stafford:

This letter is in response to the questions you asked in your letter of March 10, 1983, concerning my recent testimony before your Subcommittee.

In your first question, you asked me to comment on Levin and Rumberger's projections for the labor market in the 80's and 90's and how those projections should affect support of vocational and science and mathematics education.

I have a copy of Levin and Rumberger's full discussion paper, "The Educational Implications of High Technology." I have read the paper carefully, and, if I were to accept their basic assumptions, I must draw the same conclusions: The job market will be greatest for unskilled persons who will work as janitors, nurses aides, sales clerks, cashiers, and waiters/waitresses. The underlying assumption, however, is that these jobs will remain the same and will be unaffected by automation. Ten years ago, Levin would have predicted high employment for service station attendants. But now, with automated self-service gas pumps, the need is for high tech design, sales, repair, and maintenance personnel and few attendants. We have increased productivity in marketing gasoline.

In a similar way, as janitor service costs increase, building cleaning and maintenance will become more automated, requiring fewer persons, but opening positions in the

31st NSTA National Convention, Dallas, Texas, April 7-10, 1983

design, production, sales, and maintenance of high-tech building cleaning equipment. Sales clerks are already using holographic readers for computerized cash registers. As more retail stores automate these functions, we shall need fewer sales clerks, but more technicians to install and maintain the devices. Even now, bank cashiers are being replaced by "cash flow" devices spread throughout cities, where one does not even have to go to his own bank. These devices require constant maintenance and service. Nurses aides and orderlies are even now being assisted and made more efficient by TV monitors and other high-tech monitoring and servicing equipment in hospitals. It is those capital expenses which are largely responsible for rising medical costs.

The point, of course, is that one must be very careful about making projections about labor-intensive jobs. One invention in the high-tech area can create millions of jobs and an entire industry, as, for example, with the invention of the semiconductor.

Levin makes the point that workers will be replaced by machines, but that the machines will require less skill to operate. Therefore, he reasons, high-tech jobs are not produced. His fundamental error is in not taking into account the process of inventing, designing, engineering, producing, selling, installing, and maintaining the automatic equipment. Each of these functions requires considerably greater skill than that needed by the manual operator who originally did the job. What we gain is increased productivity. The same, or somewhat more, persons are needed for the new chain of these functions, but the output per worker is increased by an order of magnitude, thereby increasing productivity.

It is precisely the shortage of technically trained personnel which retards the creative activity of inventing new devices which would automate jobs for janitors, sales clerks, nurses aides, etc. Productivity in these fields, as well as in manufacturing, can be increased only when our work force has the scientific and technical knowledge to see on the job what must be done to improve it and to make it more efficient. As in Japan, our work force must be better able to understand the technical and scientific aspects of their work situations.

I would agree with Levin's statement on page 12 of his paper,

> ". . .it is best to provide a strong general education and an ability to adapt to a changing work environment rather than preparing persons for specific careers."

The implications of this statement, and of the other points I have made, are that support for vocational education, especially as related to production skills, should be reduced. Support for preparation of general technicians and persons with general education including a strong component of science and technology is essential if we are to improve our productivity. As Levin states it,

> ". . .general academic and vocational preparation should be stressed, as opposed to specific training, especially for young students."

Thus we need more federal support for science, math, and engineering, and less support for traditional vocational education that focuses on narrow skills.

A knowledge of the fundamentals of science, math, and technology gives one the capability of adapting to the changing technology and the changing requirements of jobs.

Your second question concerned private sector involvement in improving science and math programs. We believe that a good mechanism is one we are proposing that is modeled after the Joint Council on Economic Education. The enclosed outline, and letter of support from Ed David of Exxon, describes how the Joint Council on Science and Technology Education would bring together the resources and talents of many sectors on the problems we have identified. This Council, once created, would not be an NSTA group. It would have its own identity and operate independently, giving equal voice and responsibility to each of its members.

Your third question concerns shifting curricular emphases in the schools. The present shortages of qualified teachers are not due to curricular changes. However, if more science and math is required, the shortages will become much worse. The decade of the 60's saw relaxations in requirements, and if those requirements are strengthened, we must find a way to staff the increased number of science and math classes. If the nation's schools should require an additional science and an additional math course, we would need 80,000 more science and math teachers, a 40 percent increase.

In terms of changes the education community is willing to make, I am convinced that given the resources, changes will be readily made.

Your question about newly employed, unqualified teachers was difficult to answer. But, I was able to derive those data from our surveys:

Teaching Fields of Newly Employed, Unqualified Science and Math Teachers 1982-1983

SCIENCE TEACHERS Field of Preparation		MATH TEACHERS Field of Preparation	
Math	745	Physics	363
Other Science	1,450	Other Science	789
Business	73	Business	547
Home Economics	131	Home Economics	121
Social Sciences	280	Social Sciences	697
Physical Education	860	Physical Education	1,042
Other	1,290	Other	2,200
Total	4,829	Total	5,759

Subjects Taught by Newly Employed, Unqualified Science Teachers 1982-1983

SUBJECT	NUMBER OF TEACHERS	AS PERCENT OF TOTAL TEACHERS IN FIELD
Physics	690	8.5%
Chemistry	690	4.3
General Sciences	1,010	7.5
Geology	159	2.2
Astronomy	24	4.0
Other Physical Sciences	551	7.5
Biology	1,313	4.3
Anatomy/Physiology	48	2.0
Ecology	48	5.3
Environmental Sciences	68	4.0
Other Life Sciences	232	5.9
Total	4,829	

We do not have information on how many of the emergency hires are first-time teachers.

Thank you again, Senator Stafford, for the opportunity to present information on this crisis, and for your efforts to resolve it.

If you need other information or assistance, please let me know.

Sincerely,

Bill G. Aldridge
NSTA Executive Director

dew
Enclosures

Proposal for the Establishment of a Joint Council on Science and Technology Education

John M. Fowler
Director of Special Projects, NSTA

Background and History

February 1983

The NSTA, through its energy education projects, has worked with the Joint Council on Economic Education for several years. Its professional interests have also kept the NSTA at the forefront of the drive to publicize the growing seriousness of the shortage of science teachers and to lead efforts to improve education in science and technology in general. It is thus natural that the application of the JCEE model of a joint organization as a response to the problems in science technology education should be considered.

Discussion and planning has gone through two stages and is entering a third. The draft "tentative proposal" was developed out of discussion with the following individuals:

Michael MacDowell, President, Joint Council on Economic Education
Robert Peyton, President, Exxon Education Foundation
Leonard Jossem, Department of Physics, Ohio State University
Richard Clark, NSTA/Minnesota Department of Education
John Mays, National Institute of Education
John Layman, President, American Association of Physics Teachers
Jack Wilson, Executive Director, American Association of Physics Teachers
Jane Kahle, President, National Association of Biology Teachers
Jerry Resnick, Past President, National Association of Biology Teachers
John Carpenter, President, National Association of Geology Teachers
Sylvia Ware, Head of Educational Services Department, American Chemical Society

In December the concept was discussed at four crucial meetings with the following results:

Peter Gerber, NIE liaison to the National Commission on Excellence in Education (Department of Education). Peter saw the formation of such a group as complementing the Commission's activities and put forward the possibility of the national commission including the formation of such a joint council as a formal recommendation.

Jim Rutherford, AAAS. Jim sees no conflict between the JCSTE, as described, and the activities of the AAAS coalition. (JMF represents NSTA on the coalition steering committee.)

Frank Press, NAS. Frank sees no conflict between NAS plans and the JCSTE. He recognizes the "organizational vacuum" that presently exists and the possibility that a JCSTE could fill that vacuum.

Ray Hannapel, NSF liaison with the National Commission on Science, Mathematics and Technology Education. Ray was excited at the prospect of forming a joint group as described. He is circulating the attached description to the "Facilitation Task Force" of the Commission. He also considers possible the incorporation in the Commission Report of a resolution calling for the formation of such a group.

There are several basic questions about the role and scope of the JCSTE and we have begun to seek answers to two of the most important ones.

1. How are the companion interests and problems in mathematics education to be dealt with? (See footnote on page 3 of the tentative proposal.) A copy of the proposal and other material has been sent to Henry Pollack, Chairman, Conference Board of the Mathematical Sciences and Consultant to National Science Board Commission on Precollege Education in Mathematics, Science, and Technology, for his information and advice.

2. How are engineering education and the engineering organizations to be included? JMF met with Jack Geils of the American Society for Engineering Education in late January. Geils will discuss the proposal with Ed Lear, Executive Director of the ASEE. At his suggestion, descriptive materials have been sent to representatives of the Council for the Understanding of Technology in Human Affairs (CUTHA) and the National Action Council for Minorities in Engineering.

Descriptive materials and requests for comments and advice have also gone to:

Edward David, Jr., President, Exxon Research & Engineering Company
Morris Shamos, President, New York Academy of Science
David Robinson, Executive Vice President, Carnegie Corporation of New York
Fred Jerome, Media Resource Service Director, Scientists' Institute for Public Information
Lewis Slack, Associate Director, American Institute of Physics
Arnold Strassenburg, Department of Physics, University of Michigan

On January 28, 1983 the Executive Committee of the NSTA Board of Directors approved the tentative proposal and encouraged John Fowler to accelerate the planning with a goal of bringing such a joint organization into being by Fall 1983.

The proposal is also being submitted to COSTA (the Coalition of Science Teaching Associations--the AAPT, NABT, ACS, and NAGT are present members) for approval and support.

A series of informal "steering committee" meetings are planned for February and March which should lead to a detailed proposal. The first of these, with several representatives of business and industry, is scheduled for February 15, 1983 in New York in cooperation with the Joint Council on Economic Education.

EXXON RESEARCH AND ENGINEERING COMPANY
POST OFFICE BOX 101
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EDWARD E. DAVID, JR.
PRESIDENT

TELEPHONE 765 1267
(AREA CODE 201)

February 28, 1983

Dr. John M. Fowler
National Science Teachers Association
1742 Connecticut Avenue, N.W.
Washington, D.C. 20009

Dear John,

This letter will respond to your recent communication about the formation of a Joint Council for Science and Technology Education. Basically, we feel that the proposal has merit. Several more explicit comments follow:

1. The Joint Council for Economic Education is an excellent model for JCSTE.
2. JCSTE could provide a needed focal point for the large number of initiatives currently underway. Too many groups are working the same agenda at the moment.
3. The problems of math and science education at the pre-college level have many similarities. It would seem to us that one Council addressing the combined areas would be more effective and efficient than two.
4. "Business, industry and labor" may indeed have to play a larger role in catalyzing solutions to our educational problems. However, the ultimate resolutions will draw heavily on tax revenues.
5. The proposed timing and steps towards formation of a Council seem reasonable.

We shall follow the progress of your proposal with interest.

Sincerely,

Ed

E. E. DAVID, JR.

EED:jfk

An Organization Response to the Crisis In Science and Technology Education: A Preliminary Proposal

John M. Fowler, National Science Teachers Association

Introduction

That there are serious deficiencies in precollege education in science, mathematics and technology is widely recognized. Ample evidence for this growing problem and its consequences has been presented to Congressional hearings. It was the focus of the National Convocation on Science and Mathematics in the Schools held by the National Academies of Science and Engineering in Washington, D.C. in May 1982. The flavor of urgency that pervaded that convocation is captured by the quotations below:

> "We are raising a new generation of Americans that is scientifically and technologically illiterate." (Paul Hurd, Stanford University)
>
> "We now see our technical preeminence eroding and, if we fail to act, then 10 years from now our scientific capacity will suffer similar declines. But I see a more serious threat to our nation. . .the indicators of deterioration of the quality and quantity of education in mathematics, science and technology. . .are the unmistakable harbingers of a growing chasm between a small scientific and technological elite and a citizenry uninformed, indeed ill-informed, on issues with a science component." (John Slaughter, Director, National Science Foundation)*

The deterioration in this vital area of education shows itself in many ways; declining SAT scores, lowered requirements for precollege courses in science and mathematics, and the increasing numbers of unqualified teachers who are serving as instructors in the schools are examples.

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*"Science and Mathematics in the Schools: Report of a Convocation," National Academy of Sciences, National Academy of Engineering, Washington, DC, 1982.

The general realization of the depth and severity of the problem has led to a disparate host of responses. The National Science Board has established a National Commission on Precollege Education in Mathematics, Science and Technology. The Department of Education has an even broader "National Commission on Excellence in Education." The Education Commission of the States has established a Task Force on Education for Economic Growth which will deal specifically with needs in technological education. A "Coalition for Education in the Sciences" has been founded by many of the organizations affiliated with the AAAS and under the leadership of Dr. James Rutherford, the AAAS is undertaking several major remedial projects.

There are an equal variety of responses at the state and local level exemplified, for instance by the Alliance for Science Education, a joint effort of science, industry and education in Minnesota and the program "Scientists and Schools" established by the New York Academy of Sciences in New York City.

The eventual and necessary improvement, if it comes, will in all likelihood require not only "band aids" such as short courses to update teachers, and supplementary student teacher materials (including films and microcomputers software, etc.), but also an almost complete restructuring of values and priorities, pay scales, and curriculum in the United States educational system as a whole.

Organization Leadership

Educational "band aids" and narrowly directed efforts by individuals, individual companies or professional organizations, will, in a crisis as deep as the present one, lead to improvements. Such uncoordinated efforts will also inevitably result in duplication, inefficiency, territorial squabbles, and a waste of available resources. Leadership, through an organization that can help establish priorities, coordinate activities and marshall the necessary resources of time, talent and money, is a primary requirement for lasting success. And while all of the scientific and technological societies are concerned with the emerging problems and have either individually or jointly begun to make efforts to improve teaching and learning in their areas, the task of providing the broad, long term, and focussed leadership which the problem warrants seems clearly beyond the scope of any one organization.

Resources and Needs

Insight into the nature and scope of an organization designed to provide the necessary leadership can be gained by looking at the various constituencies who should be engaged in the drive toward improvement and at some of the resources that can be immediately or eventually brought to bear on the problems.

Mathematicians, scientists and engineers, both those who are involved in the work of their professions and those involved, through education, in the preparation of others for that work, have obvious stakes. Business, industry, and labor, as the clients for the pure and applied scientific results and for the human products of education are equally and properly concerned.

And finally, the public interest and consumer groups which deal with current socio-political conflicts in this country and the world have a stake because such conflicts now invariably contain, scientific/technical components.

In the present reality of federal withdrawal from educational support, and with state finances in deficit or near deficit condition in many parts of the country, business, industry and labor will also be called upon to provide a greater share of support for efforts to improve education than in the past.

This potential resource of financial support from business, industry and labor is paralleled by a resource of pertinent experience. It is from this sector that much of the statement of educational goals and definition of the desired products will come.

These resources from the private sector are complimented by the resources of experience and knowledge that rest with the professional mathematician, scientist and engineer and their educationally directed professional colleagues. In particular, the colleges and universities of this country are a vastly underutilized resource for the improvement of precollege teaching in science and technology, in spite of many efforts over the years to involve them.

An Organizational Model

The previous discussion of problems and resources suggests the formation of a joint organization to provide coordination, leadership and communication in a concerted effort to improve teaching and learning in science and technology. The joint effort would involve the pure sciences and mathematics, engineering, education in science, mathematics and engineering (with an emphasis in precollege education) business, industry, labor, and that part of the "public interest" sector which deals with problems of "science and society."

There are tasks and opportunities which such an organization could immediately address. The need for a representative group to balance various agendas of self interest, the usefulness of such a group in coordinating and monitoring different experimental programs and helping to locate and direct financial support, the promise such a broad and powerful group would have for constructively involving the institutions of higher education in a permanent way have been mentioned.

There is, however, an even more immediate focus for a beginning agenda. The National Commission on Excellence in Education will make its report in the spring of 1983, the National Science Board's Commission on Precollege Education in Mathematics, Science and Technology will report in late 1983 as will the ECS Task Force under Governor Hunt. These reports, one can be certain, will contain not only careful analyses of the problems but recommendations for actions leading toward solutions. A joint group bringing together the leaders from the constituent groups previously described would be an ideal organization to give priorities, seek funding, and move to implement the relevant recommendations of these reports.

There is an explicit model of a group with such a joint structure, and with similar responsibilities: The Joint Council on Economic Education (JCEE). A brief description of the JCEE illustrates at least some of the ways in which that structure might be adaptable to science and technology education.

> "The Joint Council is an independent, nonprofit, nonpartisian, educational organization, incorporated in 1949 to encourage, improve, coordinate, and service economic education.
>
> Our mission is to improve the quality and increase the quantity of economics taught in our schools and colleges. By focusing on the curriculum, our mission can be accomplished through better prepared teachers using effective teaching materials.
>
> Members of our Board of Trustees represent all sectors of the economy. Financial support comes from foundations, business, organized labor, farm groups, and individuals. This "jointness" is a crucial factor in the Council's reputation for objectivity in our schools and colleges.
>
> The Joint Council's principal medium for expanding and improving economic education is a network of 50 state Councils and 230 Centers for Economic Education operating on college and university campuses."*

In this brief quotation the relevance of the JCEE model to the task in science and technology education is made clear. It has had a similar task in economic education, its "jointness" is similar, and its procedures (working through State Councils and "Centers for Economic Education: at colleges and universities) are worthy of careful consideration for adoption in science and technology education.

There are dissimilarities. Economics is a more precisely defined educational area than "science and technology education." The JCEE was founded to introduce economics into curricula which did not contain it. Science and mathematics education exists, but with unsatisfactory quantity and quality. Although these and other differences mean that details of structure and procedure of a "Joint Council on Science and Technology Education" would differ from those at JCEE, it appears to us that the broad model is sufficiently applicable to make it worthy of consideration.

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*Joint Council on Economic Education; Annual Report 1981-82; 1212 Avenue of the Americas, New York, NY 10036.

A Joint Council for Science and Technology Education

The NSTA is proposing the establishment of a "Joint Council for Science and Technology Education" (JCSTE).* This Joint Council will have, as its defining mission, to encourage and improve precollege teaching and learning in mathematics, science and technology.

We suggest, in fact, that the educational target be restricted to the second and third goals defined by the first report of the Commission on Precollege Education in Mathematics, Science and Technology. These three goals are:

- To continue to develop and to broaden the pool of students who are well prepared and highly motivated for advanced careers in mathematics, science and engineering.
- To widen the range of high-quality educational offerings in mathematics, science and technology at all grade levels, so that more students would be prepared for and thus have greater options to choose among technically oriented careers and professions; and
- To increase the general mathematics, science and technology literacy of all citizens for life, work and full participation in the society of the future.**

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*A tentative title for the purpose of this proposal; obviously any such organization would eventually select its own title.

**"Todays Problems, Tomorrows Crisis,"Report of the National Science Board Commission on Precollege Education in Mathematics, Science and Technology, Washington, DC, October, 1982.

Not only is the first goal, in the opinion of many, being adequately met, but it is also primarily a responsibility of the specific disciplines. In meeting the second and third goals, however, the joint approach we have described, is obviously called for.

The JCSTE would be composed of individuals selected for their national prominence and creative efforts for mathematics, science and technology education and of representatives from professional organizations. Individuals and organizations would represent mathematics, science, education, business, industry, labor, and the public interest groups.

Tasks: An operating JCSTE will, of course, identify its own tasks. We suggest as descriptive examples and possibilities for discussion, the following:

1. Follow-up action on the recommendations of the "Commission on Precollege Education in Mathematics, Science and Technology," the "National Commission on Excellence in Education," and The ECS Task Force on "Education for Economic Growth."
2. Compile and exchange information on the many ad hoc joint efforts to improve mathematics, science and technology education that are developing around the country. These state-based joint efforts could form the framework for eventual state joint councils.
3. Establish a joint task force to define curricular and skills objectives for K-12 mathematics, science and technology education.
4. Establish a task force to develop guidelines and objectives for in-service and pre-service efforts to improve teaching in mathematics, science, and technology.
5. Begin the design, in cooperation with state efforts, of mechanisms to provide the necessary in-service and pre-service teacher training.
6. Develop mechanisms for presenting the present inadequacies of mathematics, science, and technology education to the general public.

Timetable

A group such as the JCSTE is not formed by fiat by an organization or a group of organizations. The NSTA proposes to gather organizational and individual support for this idea and then to submit, to an appropriate funding source, a proposal to plan and conduct a three day working conference spanning the constituencies described. This conference should ideally take place in late summer 1983. By that time the various National Commissions and Task Forces (earlier described) would have developed results and recommendations which would serve as conference input.

The 50 to 60 Conference attendees would be viewed as representing those autonomous groups and constituencies with a stake in science education. These groups would include the most active state efforts, professional organizations such as the NSTA and the AAAS, the discipline-specific organizations such as the AIP and the ACS, The teaching organizations in mathematics, physics, chemistry, biology, engineering, etc., labor (both the AFL-CIO and specific unions such as the AFT), the industry trade associations such as the Edison Electric Institute and the American Petroleum Institute, and selected public interest groups. Business, industry and science would also be represented through individual leaders.

The charge to the Conference for its three or so days of activity would be to develop a response to the analyses and recommendations presented to it. The participants would be specifically asked to consider a structural or organizational response--in particular, asked to examine and answer the question: Would a national organization which acted as a service group to and link for the various state groups and interested professional organizations be useful enough to justify its formation? If the Conference recommended the establishment of such an organization, the participants would be asked to begin the tasks of 1) forming such an organization 2) defining its structure and method of operation and 3) defining its scope of operation, i.e., defining "precollege science education."

In any event the conference role would be to recommend some organizational response to the needs and recommendations and to put in motion a mechanism or mechanisms for meeting them.

An organization formed by this conference could thus begin operation by Fall 1983 and be in position both to provide continuity with the National Commissions, etc. and to provide guidance and help establish national priorities for the developing Congressional efforts in this area.

Meeting to Discuss NSTA's Proposal to Form a Joint Organization for Science and Technology Education

Tuesday, February 15, 1983
10:00am-12:00pm
Joint Council on Economic Education

Present

Tom Ford
La Guardia Community College

Sol Hurwitz
Senior Vice President
Committee for Economic Development

Richard Arnold
Manager, Educational Relations
American Telephone & Telegraph Company

E.J. Clark
Manager, Educational Communications Program
General Electric Company

Mike MacDowell
President
Joint Council on Economic Education

John Fowler
Director of Special Projects
National Science Teachers Association

Summary of Discussion

The problem of precollege education in the interacting area of mathematics, science and technology is a serious one and is but an obvious component of broad and serious inadequacies in precollege education. Much of the early discussion at this meeting revolved around questions of definition (What is meant by science and technology education?) and of targeting a student audience for such education.

In the terms used by the National Commission on Precollege Education in Mathematics, Science and Technology, there are three different goals, representing three different student audiences.

1. To continue to develop and to broaden the pool of students who are well prepared and highly motivated for advanced careers in mathematics, science and engineering.

2. To widen the range of high-quality educational offerings in mathematics, science and technlogy at all grade levels, so that more students would be prepared for and thus have greater options to choose among technically oriented careers and professions; and

3. To increase the general mathematics, science and technology literacy of all citizens for life, work and full participation in the society of the future.*

It was the consensus of the group that the first goal was being adequately served by education, that the second goal was the most politically attractive one since it could be seen in terms of jobs, while the third goal, whose achievement is perhaps the most difficult and whose attainment would lead through controversy, receives much "lip service", but has the weakest political support.

The joint organization (which we will continue to call in this summary, the Joint Council on Science and Technology Education, JCSTE, although modifications of that name are probably worthwhile) is expected to be concerned with goals 2 and 3. Goal 1 is best served by discipline-specific groups.

There was a suggestion that while goals 2 and 3 were distinct, there is considerable overlap in the student audience addressed and, quite likely, in the curricular approaches which could be devised to achieve these two goals. It was also apparent to the group that there was no generally agreed to definition of what "science and technology" education means for either of these last two groups. A "chicken and egg" situation is created. Is such a definition needed to stimulate and guide the formation of a JCSTE? Is consensus on such a definition a high priority task for a JCSTE? These questions are returned to in the closing paragraphs.

There are also "minority reports" in circulation which despair of ever attaining broad scientific and technological literacy and which further point out that "high tech" production lines are apt to be as boring and nonskilled as those which "high tech" competition is making obsolete. They warn against overtraining the work force.

It seemed a group consensus that, in spite of the recognized difficulties, the understanding of mathematics, science and technology achieved by the general student needed to be deepened and refined and that improving this understanding remained an important national goal of education.

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*"Todays Problems, Tomorrows Crisis," Report of the National Science Board Commission on Precollege Education in Mathematics, Science and Technology, Washington, DC, October 1982.

Breadth of a JCSTE

Two questions arose about the breadth of a JCSTE. In the existing description (NSTA's "Tentative Proposal") mathematics is excluded and the role of engineering left uncertain (discussions of engineering's role are underway with Jack Geils and Ed Lear of the ASEE). There were strong and convincing rationales produced for the inclusion of the mathematics teaching community on a JCSTE. Fowler will continue discussions with Dr. Henry Pollak of Bell Labs and other representatives from mathematics. It was also pointed out that the armed forces and federal scientific operations had a stake in science education. The roles of such groups is clearly a subject for further discussion.

Process vs Product

Much of the discussion developed from the question "What will a JCSTE do?" The field of math, science and technology education (hereafter "science education" for brevity) is sprouting numerous organizations (Clark distributed a list he had compiled) and specific projects. Rutherford's new junior high science project at the AAAS, Northrop Corporation's broader educational effort for Hispanic students in California, are two examples. There is some tension between those who feel that "monolithic organizations" are part of the problem and prefer local, specific, grassroots efforts, and those who see important coordinating, communicating, and servicing responsibilities for a national organization.

Mechanisms for resolving this dicotomy are proposed below.

Role of State Joint Efforts

An important new development in science education is the formation, in state after state, of joint organizations (typically science, education, business and labor) to study the state's educational needs and problems and recommend steps toward solutions. Reflecting the importance of the state efforts is the formation of the ECS Task Force on Education for Economic Growth under Governor Hunt of NC. From the discussion it emerged that this ECS Task Force is perceived as potentially the most influencial of the ones in existence. It was further suggested that not only should there be a strong link between state efforts and a JCSTE, but also that the state efforts should be represented from the beginning in any planning for a JCSTE.

The group also was in agreement that the action points in future efforts to improve science education will be in the state and local school districts. A JCSTE will be useful not so much to direct and coordinate these local activities, but to connect and service them (with advice and occasionally materials, for instance). The Joint Council for Economic Education "federated" model seems an attractive one for science to follow.

Conclusions

The need for implementation, definition and coordination in science education was strongly emphasized by the group. But the participants also recognized a resistance to "forming another organization" and to the implied concentration of power. They also described new groups already forming and new activity in existing groups which could lead to "battles over turf."

The viability and utility of a JCSTE cannot be taken for granted. The need for it, its purposes, and its political support must, the group felt, be developed before it can come into being. The financial implications of its formation and operation need to be spelled out.

The participants accepted, as a feasible first step or "phase I" for NSTA, the organization of a working conference, perhaps as early as late summer 1983, to consider the questions of need, definition, turf (political) and financial implications.

The purpose of this conference would be to consider the analyses of the state of science education and the recommendations for its improvement generated by the various national commissions and task forces, along with the outputs from various state joint studies. The NSTA will undertake to collect and summarize such information, commission "position papers" where necessary in order to provide concise informational input to the Conference.

The 50 to 60 Conference attendees would be viewed as representing those autonomous groups and constituencies with a stake in science education. These groups would include the most active state efforts, professional organizations such as the NSTA and the AAAS, the discipline-specific organizations such as the AIP and the ACS, the teaching organizations in mathematics, physics, chemistry, biology, engineering, etc., labor (both the AFL-CIO and specific unions such as the AFT), the industry trade associations such as the Edison Electric Institute and the American Petroleum Institute, and selected public interest groups. Business, industry and science would also be represented through individual leaders.

The charge to the Conference for its three or so days of activity would be to develop a response to the analyses and recommendations presented to it. The participants would be specifically asked to consider a structural or organizational response--in particular, asked to examine and answer the question: Would a national organization which acted as a service group to and link for the various state groups and interested professional organizations be useful enough to justify its formation? If the Conference recommended the establishment of such an organization, the participants would be asked to begin the tasks of 1) forming such an organization 2) defining its structure and method of operation and 3) defining its scope of operation, i.e., defining "precollege science education".

In any event the conference role would be to recommend some organizational response to the needs and recommendations and to put in motion a mechanism or mechanisms for meeting them.

The NSTA will seek sponsorship and commitments to such a conference among the groups with which it is presently discussing the formation of a JCSTE, will prepare a rationale and budget, and seek funding.

The Educational Implications of High Technology

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Institute for Research on Educational
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Stanford University

New advances in technology--in genetic engineering, in robotics, and particularly in computers--are transforming the lives of Americans in the home and the workplace. While the micro-computer has signalled the arrival of "high-technology" in the home, many observers believe that its influence in the workplace will be even more profound. Not only do industries producing micro-processors, robots, and the fruits of bio-technology promise rapid growth in sales and employment, but micro-computers and robots are also expected to transform other industries and occupations throughout the economy. One observer predicted that 40 to 50 percent of all American workers will be using electronic terminals by 1990 (Giuliano 1982, p. 152).

Government leaders, Republican and Democrat alike, see the growth of high-technology as one key to solving America's current economic problems. As President Reagan said in his state of the union message on January 25, 1982:

> But, as surely as American's pioneer spirit made us the industrial giant of the 20th century, the same pioneer spirit today is opening up another vast frontier of opportunity--the frontier of high technology. In conquering this frontier, we cannot write off our traditional industries, but must develop the skills and industries that will make us a pioneer of tomorrow.

Business leaders have echoed this sentiment, calling upon the educational system to make the changes necessary to provide enough skilled workers to fuel the growth of high technology. As Steven Jobs, co-founder of Apple Computer, recently stated: "A massive retraining effort by government and private industry could alleviate the problem of job skill obsolescence created by the expanding computer industry" (Stanford Daily 1983).

Educational policymakers have proposed vast changes in the educational system to respond to these challenges. The proposed changes are based on the belief that our high-technology future will require workers with more sophisticated job skills. A recent publication from the Education Commission of the States (1982) exemplifies this widespread belief:

> Occupational growth throughout the 1980s is projected to expand most rapidly in the higher-skilled, technical occupations. Tomorrow's workers will likely need improved skills in the selection and communication of information. Many of today's skills considered to be of a "higher" level are the potential basic skills of tomorrow (p. 1).

Such beliefs have prompted proposals to upgrade math and science education in our nation's secondary schools, to place computers in all elementary and secondary schools, and to generate $ 1 billion dollars in new support for high-technology education (Botkin, Dimancescu, and Stata 1983).

These concerns are based on two assumptions. First, future job growth in the United States will favor professional and technical level jobs--such as engineers and computer programmers--that require considerable education and sophisticated training in computer-related areas. Second, high technology will upgrade the skill requirements of existing jobs because workers in those jobs will work increasingly with technologically sophisticated equipment, such as computers.

Despite the widespread propagation of these assumptions, both are contradicted by the available evidence. Neither will most new jobs be in high technology occupations, nor will the application of high technology in existing jobs require a vast upgrading of the skills of the American labor force. To the contrary, the expansion of the lowest skill jobs in the American economy will vastly outstrip the growth of high technology ones. And the proliferation of high technology industries and their products is far more likely to reduce the skill requirements for jobs in the U.S. economy than to upgrade them.

In the remainder of this paper we will examine the two common assumptions about high technology and the supporting evidence in greater detail. We will then discuss the educational implications of our high-technology future.

Future Employment Growth

To what degree will high technology jobs dominate future employment growth? Accurate predictions on the composition of future employment depend on the analysis of a large number of factors. These include such influences as economic growth, labor force demography, foreign trade movements (many which are influenced by changes in international exchange rates), technological breakthroughs, and decisions of multi-national organizations with respect to the international rationalization of production. Many of these factors are difficult to predict, in themselves, because they are subject to a large number of political and economic vagaries on a world scale.

While no methodology is likely to be provide completely accurate results, those that consider a large number of pertinent influences are likely to be superior to simple extrapolations or other uncomplicated projections. In this respect, the estimates of the Bureau of Labor Statistics (BLS) of the U. S. Department of Labor represent some of the most refined attempts to project the growth and composition of future employment.

Since the 1960s BLS has periodically conducted a series of projection studies based on an economic growth model. Over the last two decades "the methodology has been continually modified to include greater industrial detail, other models, more rigorous analytical techniques, a more automatic system for processing calculations, and broader coverage including labor force and occupations in the current version" (Oliver 1982, p. 1). The methodology incorporates a number of assumptions about growth in the labor force, economic output, and productivity. Further, in order to allow for uncertainty, recent projections--for the year 1990--are based on three different scenarios regarding the growth of these various factors. The more optimistic projections assume high growth rates in economic output and productivity, while the more conservative projections assume lower growth rates.

The employment projections are based on occupational employment patterns within detailed industries in 1978, projected employment patterns within these industries in 1990, and projected total employment within each industry based on the economic projections. It is important to note that employment growth refers only to new jobs that are added to the economy rather than job openings. Job openings will be much higher. BLS estimates that employment growth will account for only one-third of total job openings between 1978 and 1990, with the remaining two-thirds due to the replacement of workers in existing jobs who withdraw from the labor force because of death, retirement, or other reasons (U.S. Bureau of Labor Statistics 1980, p. 6).

We will limit our discussion to employment growth due to the projected creation of new jobs using the BLS figures based on assumptions of modest growth rates. According to these figures, employment will increase by 22 million or 23 percent between 1978 and 1990 (Table 1). The fastest growing job categories in relative terms--percentage change between 1978 and 1990--includes a number of high technology areas. This projected expansion has apparently led to the commonplace assumption that aggregate job growth will be biased towards high technology occupations. Of the five fastest growing occupations, three--data processing machine mechanics, computer systems analysts, and computer operators--deal with high-technology products. Employment in these five occupations is projected to increase by over 100 percent, more than four times the employment growth rate in all occupations.

Such percentage changes are misleading, however. The total number of new jobs generated in these and other high technology occupations will be vastly outweighed by employment growth in other areas. Slower-growing occupations with a large employment base are expected to contribute far more jobs to the economy than high technology occupations. Of the 20 occupations that are expected to generate the most jobs in the economy during this period, not one is related to high technology. As Table 1 shows, the five occupations that are expected to produce the most new jobs are all in low skilled areas: janitors, nurses' aides, sales clerks, cashiers, and waiters and waitresses. These five jobs alone will account for 13 percent of the total employment growth between 1978 and 1990. Only 3 or 4 of the 'top 20' occupations in terms of total contribution to job growth require education beyond the secondary level, and only two require a college degree (teaching and nursing).

This picture is further reinforced by examination of individual high technology job categories. While jobs for computer systems analysts will increase by over 100 percent between 1978 and 1990, only 200,000 new jobs will be created. In contrast, there will be over 600,000 new jobs for janitors and sextons. In fact, more new jobs for janitors will be created than new jobs in all the five occupations with the highest relative growth rates. Consider another example: about 150,000 new jobs for computer programmers are expected to emerge during the 12 year period, a level of growth that is vastly outpaced by the 800,000 new jobs expected for fast food workers and kitchen helpers.

Employment growth for the economy as a whole will favor low and middle level occupations rather than higher level ones. While employment in professional and technical occupations is expected to increase by 20 percent for the twelve year period, this growth rate is lower than in either of the two preceding decades (Table 2). Employment in all professional and managerial occupations increased by 36 percent between 1960 and 1970, and 45 percent between 1970 and 1980. But it is projected to increase by only 28 percent between 1978 and 1990. Clerical and service occupations will account for 40 percent of the employment growth during this decade.

Many of the predictions of high growth of technical employment tends to be based on the fallacious assumption that high percentage growth rates for occupations are equivalent to high absolute increases in jobs. Other projections are based on industry surveys of future employment needs. For example, the American Electronics Association recently predicted 200,000 new openings for electrical and computer engineers in U.S. electronics industries between 1981 and 1985, based on a 1981 survey of anticipated engineering needs in major electronics firms (Hubbard 1981). Predictions of employment decline in particular occupations are often based on similar techniques. For example, researchers at the Robotics Institute at Carnegie-Mellon University recently estimated the extent of decline in the number of machine operatives in metal working industries based on 16 employer responses to a survey on anticipated replacement of operative positions by industrial robots (Ayres and Miller 1981-82).

While such predictions may suggest future trends in employment growth, they are not based on a systematic analysis of the many economic factors that will influence economic and employment growth in these industries. Further, they do not provide an indication of employment growth for the economy as a whole. Accordingly, with all of the potential uncertainties underlying the BLS forecasts, we believe that they are superior to existing industry surveys and are supported by other government analyses such as those of the Department of Defense (Choate 1983).

In summary, government estimates suggest that employment growth will favor jobs that require little or no training beyond the high school level. Although employment in high technology occupations will increase quickly in percentage terms over this decade, the contribution of these jobs to total employment growth will be quite small.

The Impact of Technology on Existing Jobs

While the growth of high technology occupations will not have a major impact on overall employment growth in the foreseeable future, high technology will have a profound impact on many jobs in the economy. Increasingly workers in a variety of work settings will find their jobs altered by sophisticated computer technologies. Secretaries will work with word processing equipment; bookkeepers will use computerized, financial spread sheets; clerical workers in purchasing and inventory will apply their skills to automated and computerized record systems; mechanics will use diagnostic equipment employing mini-computers; and telephone operators will rely on computerized directories. But will the use of these new technologies require workers with more sophisticated skills?

In order to answer this question, it is necessary to examine how technology is applied in the workplace. The application of technology is part of a more fundamental process that has characterized production historically--the process of dividing work tasks into simplified operations that require few skills to perform. Through this process production tasks are fragmented into repetitive and routinized activities for which unskilled and low paid workers can be employed. This movement towards a minute division of labor was first advocated by Adam Smith in The Wealth of Nations and later refined by Charles Babbage:

> Babbage's principle is fundamental to the evolution of the division of labor...it gives expression not to a technical aspect of the division of labor, but to its social aspect. Insofar as the labor process may be dissociated, it may be separated into elements some of which are simpler than others and each of which is simpler than the whole. Translated into market terms, this means that the labor power capable of performing the process may be purchased more cheaply as dissociated elements than as a capacity integrated in a single worker. Applied first to the handicrafts and then to the mechanical crafts, Babbage's principle eventually becomes the underlying force governing all forms of work ...no matter in what setting or at what hierarchical level (Braverman 1974, pp. 81-82.

Technology aids this process. The division of work tasks into component parts is often accompanied by the mechanization of some of those tasks. For example, the assembly line adopted by Henry Ford early in this century, although first controlled by nonmechanical methods, was soon mechanized (Gartman 1979, p. 200). As technology advances, an increasing number of work tasks can be mechanized. Advances in micro-electronics, in particular, threaten to further fragment work tasks and contribute to the "deskilling" of jobs (Cooley 1983).

The process of fragmentation not only allows employers to lower their costs, but to better control the production process. The organization of work in the United States has evolved from a large number of small, local units into a much smaller number of large, hierarchical, national and international organizations. This transformation has been accompanied by more sophisticated methods of control (Marglin 1974; Edwards 1979).

Technology also aids efforts to control the workplace:

> Machinery offers to management the opportunity to do by wholly mechanized means that which it had previously attempted to do by organization and disciplinary means. The fact that many machines may be paced and controlled according to centralized decisions, and that these controls may thus be in the hands of management, removed from the site of production to the office--these technical possibilities are of just as great interest to management as the fact that the machine multiplies the productivity of labor (Braverman 1974, p. 195).

In the case of the automotive assembly line, for example, mechanization not only reduced labor costs but allowed management to more easily control the pace of production (Gartman 1979).

It is often asserted that while machines will increasingly perform tasks previously performed by workers, generally they will perform the most tedious and least skilled tasks. That is the most desirable and challenging tasks will continue to be performed by workers. Further, as automation becomes more widespread, with more and more workers using complex, sophisticated machines, they will need increasingly complex skills to work with them (Figure 1, Exhibit 1).

James Bright, a professor at the Harvard Business School, investigated similar claims more than 20 years ago. During the 1950s, Bright examined the effects of automation on job skill requirements in a variety of U.S. manufacturing firms. Contrary to the general assumptions that were as common then as they are today, Bright (1958) observed that the skill requirements of jobs first increased and then decreased sharply as the degree of mechanization increased (Figure 1, Exhibit 2):

> ...there was more evidence that automation has reduced the skill requirements of the operating work force, and occasionally of the entire factor force including the maintenance organization...automated machinery tends to require less operator skill after certain levels of mechanization are achieved. It seems that the average worker will master different jobs more quickly and easily in the use of highly automatic machinery. Many so-called key skilled jobs,

> currently requiring long experience and training, will be reduced to easily learned, machine-tending jobs (pp. 86-87).

Evidence for the United States as a whole support Bright's conclusions: aggregate skill requirements of jobs in the U.S. economy have changed very little over the last two decades despite widespread automation in many industries (Rumberger 1981).

Case studies that have documented the application of more recent technologies in a wide variety of work settings confirm this tendency (Zimbalist 1979a). For example, many of the jobs in the printing industry, such as typesetting, press operating, and photoengraving, historically have required highly complex craft skills (Zimbalist 1979b). A series of technological advances over the last 30 years has enabled many of these operations to be performed by machines: first the introduction of teletypesetting machines in the 1950s took over many of the manual typesetting operations; then the introduction of computer-aided phototypesetting in the 1960s took over the tasks of word hyphenation and line justification; and finally the introduction of video display terminals removed the tasks of composing from the press floor altogether (Zimbalist 1979b, pp. 107-109). These advances reduced sharply the skill levels of workers who remained in the newspaper composing room.

The computer industry itself, the heart of the high technology revolution, provides another case. Early computers, not only were large and expensive by today's standards, they required programmers and operators with fairly complex skills to use them (Kraft 1977; Greenbaum 1979). But as the technology changed, so did the tasks and the skills involved in their operation. Computer programming was soon divided into the more creative, skilled tasks--performed by computer systems analysts--and the more tedious, routine tasks--performed by computer programers and coders. Programming itself became easier as computer languages evolved from high-level machine languages to packaged programs to more "user-friendly", menu-prompted packages (Kraft 1977).

Advances made in computer software have meant that workers can use computers in a wide variety of work settings without any knowledge of computer languages. The new generation of office computers, for example, are specifically designed so that "no special computer skills are needed to operate" them (Giuliano 1982, p. 149). Moreover, office computers perform many of the tasks formerly done by secretaries, actually reducing the requisite skills of office work (Glenn and Feldberg 1979). Word processors can correct typing errors automatically by use of electronic dictionaries, so letter-perfect typing and strong spelling skills are no longer required. In addition, supervisors can monitor each operator's output and compare productivity among workers instantaneously (Glenn and Feldberg 1979; Arnold, Birke, and Faulkner 1981).

Computers and other products of the micro-electronics revolution are transforming work in virtually all sectors of the economy, from agriculture to transportation to engineering design (Scientific American 1982). The future suggests that this transformation will become even more widespread and that technologies will become increasingly sophisticated. Machines will be able to perform more complex, mental tasks as more advanced software is developed. But the use of such sophisticated equipment will not necessarily require workers with more sophisticated skills. In fact, past technological advances suggest the opposite is often the case. The automobile of today is far more sophisticated today than its predecessor of fifty years ago. Yet it is far easier to drive than today's vehicle. Computers are far more sophisticated today than they were 10 or 20 years ago. But programming and using computers is considerably less demanding today, and many computer-related jobs require virtually no knowledge of computers.

A related concern is that entire classes of skilled workers will disappear or be severely reduced in numbers as their jobs are replaced by robots or computer software. For example, robots could replace up to 3 million operative jobs in the next 20 years and potentially eliminate all 8 million operative positions--currently 8 percent of the workforce--by the year 2025 (Ayres and Miller 1982, p. 42). The widespread use of computer-aided design (CAD) may virtually eliminate the occupation of drafter in the not-too-distant future, a potential loss of 300,000 skilled positions (Gunn 1982).

It is clear that applications of high technology can be used to enhance the quality of working life and the utilization of worker skills or to reduce them (Walton 1982). The outcome will depend upon how the technologies are applied and how employers use them. Past applications of technology in the workplace as well as present evidence suggest that future technologies will further simplify and routinize work tasks and reduce opportunities for worker individuality and judgement. Moreover, the displacement in jobs and the downgrading of skill requirements for most of the new positions will undermine employment generally, and especially the employment of skilled workers.

Educational Implications

Given the widely advertised view that high technology will dominate the demand for new workers and raise skill requirements of jobs, the usual educational prescription is that there must be a vast transformation of the educational system to provide the appropriate skills. It is assumed that rising skill levels for employment will require more training in mathematics, computer science, and technical applications for the labor force as a whole as well as an increasing number of workers with specialized training in these fields. Consequently, schools must adapt to these new responsibilities through major upgrading of mathematics and science curricula and teacher preparation. Schools also need to establish specialized courses of study in computer applications and programming in order to provide vocational training for high school and community college students in these areas.

We have asserted, however, that while some jobs will require these skills, the vast majority of jobs will not. Indeed, one of the major purposes and effects of high technology is to simplify or reduce the skill requirements for performing a particular work task. With the exception of a relatively small number of highly specialized positions for designing and implementing high technology applications, most jobs will not require higher skill levels. Industrial shifts and technological change may require different skills, but the preponderance of persons who are affected by such shifts will not need more mathematics or computer science. And, for significant numbers of jobs, the skill requirements that will have to be met will be less-demanding.

Based upon these assessments, what educational policies are implied?

First, the general educational requirements for creating good citizens and productive workers are not likely to be altered significantly by high technology. Nonetheless, everyone should acquire strong analytic, expressive, communicative, and computational skills as well as extensive knowledge of political economic, social, and cultural institutions. These aptitudes and knowledge are required for daily understanding and for having access to available social opportunities. To the degree that the present schools fall short of providing these results, they should be sought for their own sake rather than because of the claim that they are required for a high technology future.

Second, since we can not predict in any precise sense which jobs will be available to particular persons, which jobs they will select from among those available, and what the characteristics of jobs will be over a forty year working life, it is best to provide a strong general education and an ability to adapt to a changing work environment rather than preparing persons for specific careers. Such adaptation requires a sufficient store of information about culture, language, society and technology as well as the ability to apply that information and acquire new knowledge as it is needed. Accordingly, general academic and vocational preparation should be stressed, as opposed to specific training, especially for young students.

Specific job skills can best be learned on the job, if a worker's general background is sufficient (Thurow 1975). Recent surveys of both U.S. and British employers indicate that they seek new employees with a sound education and good work habits rather than narrow vocational skills (Maguire and Ashton 1981; Wilms 1983).

Third, if changes in work requirements tend to arise more abruptly and at a faster rate than previously, the educational system may need to establish new approaches that can respond more quickly and efficiently to training needs. It may require better ties with industry and should not exclude the possibility of more industry-based training activities. It should also be tied to a system of recurrent education, since workers will no longer be able to acquire a set of job skills at the beginning of their careers that will useful over their entire work lives (Levin and Schutze 1983; Mushkin 1974).

In summary, the educational implications of high technology are that a solid basic education rather than narrow vocational preparation will become more important, not less important, in the future. This will require a strengthening of elementary and secondary schools in virtually all areas that require analytical and communicative skills as well as emphasizing a much greater commonality in post-secondary studies. The emphasis must be on providing a foundation that will enable people to continue to learn over their lifetimes as new knowledge is needed. This capability will also require a move towards recurrent education so that opportunities are provided over the career span to undertake new training and to move from declining occupations to expanding ones.

Figure 1

The Relationship Between Increasing Levels of Automation
and Job Skill Requirements

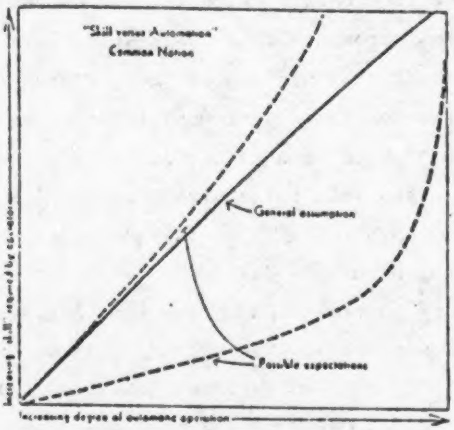

EXHIBIT 1.—HOW DEMANDS ON THE WORKER ARE COMMONLY ASSUMED TO INCREASE WITH AUTOMATION

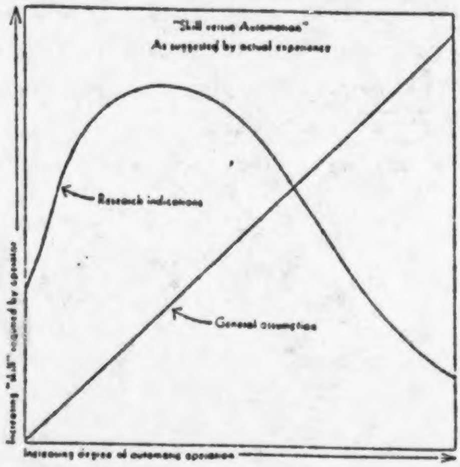

EXHIBIT 2.—HOW DEMANDS ON THE WORKER INCREASE WITH AUTOMATION AS INDICATED BY FIELD STUDIES

Source: Bright (1966), pp. II-208-209.

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Table 1

Employment and Employment Growth in the Fastest Growing Occupations: 1978-90

			Employment Growth 1978-90		
	Employment (thousands)			Number of Jobs	
Occupations	1978	1990	Percentage Increase	(thousands)	(percent of all occupations)
Fastest relative growth[a]					
1. Data processing machine mechanics	63	156	148	93	0.4
2. Paralegal	28	66	132	38	0.2
3. Computer systems analysts	185	384	108	199	0.9
4. Computer operators	169	317	88	148	0.7
5. Office machine and cash register servicers	49	89	81	40	0.2
Total	494	1012	105	518	2.4
Fastest absolute growth[b]					
1. Janitors and sextons	2585	3257	26	672	3.1
2. Nurses' aides and orderlies	1089	1683	55	594	2.7
3. Sales clerks	2771	3362	21	591	2.7
4. Cashiers	1501	2046	36	545	2.5
5. Waiters/Waitresses	1539	2071	35	532	2.4
Total	9485	12419	31	2934	13.3
Total, all occupations	97610	119590	23	21980	100.0

[a] Based on the percentage increase in the number of jobs created

[b] Based on the number of new jobs created

Source: Carey (1981), Table 2

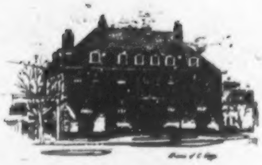
Table 2

Employment Growth by Major Occupation Group:

1960-90

	Employment Growth (percentage distribution)		
Major Occupation Group	1960-70 (1)	1970-80 (2)	1978-90 (3)
Professional and technical	30.0	22.3	20.3
Managerial	6.0	22.7	7.7
Sales	5.8	2.6	7.0
Clerical	32.9	21.0	20.0
Crafts	11.2	9.5	12.2
Operatives	7.5	1.8	10.0
Laborers	.7	4.8	4.8
Farm workers	-14.5	- .2	- 2.6
Service	20.4	15.5	20.7
Total	100.0	100.0	100.0

Sources: (1)-(2) Rumberger (1983), Table 2; (3) Carey (1981), Table 2.



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An Affiliate of the American
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Advancement of Science

March 31, 1983

Senator Claiborne Pell
Subcommittee on Education,
Arts and Humanities
U.S. Senate
325 Russell Senate Office Building
Washington, DC 20510

Dear Senator Pell:

Senator Stafford asked that I respond to questions you have asked about my testimony before your Committee. As was clear in my testimony, I feel very strongly that federal support should be targeted in such ways as to efficiently address the crisis in science education.

Large block grant formula programs are not going to solve the problems. From analyses that I have made, I am convinced that $150-$200 million properly placed could easily move us toward resolution of the crisis. Yet what I see happening is amounts double or triple being spread out and diluted in ways that will not significantly improve the situation. For example, I have enclosed an outline of a complete science education program at the National Science Foundation which would properly address the crisis in all areas and at all levels, including graduate education support.

Let me respond to a couple of your specific questions; however, I would urge you to read my enclosed letters to Senators Garn and Stafford. If there must be block grant support, it should go without matching requirements and be targeted to those schools which can demonstrate a need, rather then on the basis of some formula. Your question number 3, in regard to high technology and vocational education, is discussed at length in my enclosed letter to Senator Stafford. Your question number 4 is an important one. The matter of image of teaching is probably just as important as salary or anything else. Improving that image can

BILL G. ALDRIDGE
Executive Director
202/328-5810

31st NSTA National Convention, Dallas, Texas, April 7-10, 1983

occur in a couple of ways. First, awards for excellence and recognition by the President making those awards will greatly improve the image of teaching of science and mathematics. Second, summer institutes and research programs with university and research scientists will help teachers identify with their disciplines and give them status that means far more than just salary. Your question number 5 relates to obsolete materials. I have responded to this question in my letter to Senator Garn and in my original testimony. This is one of the most critical problems because the present materials are not only obsolete, but inappropriate. The problem must be addressed at the national level unless you are prepared to invent the wheel over and over again in 16,000 different school districts.

In summary, I would urge you to create a bill with an appropriate balance of support at NIE, NSF, and through block grants directly to those groups, agencies, or schools that can demonstrate a need, but not on some formula basis. At NIE and NSF, programs should be administered on merit as determined by programs or projects which can best improve the current situation.

Thank you for the opportunity to provide further information.

Sincerely,

Bill G. Aldridge
NSTA Executive Director

dew
Enclosures
CC to: David Morse

A 1984 Program Outline and Tentative Budget
for NSF Support of Mathematics, Science, and Engineering Education

I. Program Evaluation and Assessment ($3 Million)

All levels 7-12, undergraduate and graduate

A. Supply and demand

Need for graduates and faculty in mathematics, science, and engineering

B. Content effectiveness

Analysis and assessment of curriculum and course content including sequence, scope, and delivery mechanisms

C. Resource adequacy

Instrumentation in instructional laboratories, utilization of TV and other media, use of computers in classroom and laboratory instruction

D. NSF Program Review and Analysis

Evaluation of NSF mathematics, science, and engineering education programs in terms of national needs and program objectives

II. Coordination and Communication of Mathematics, Science, and Engineering Education Initiatives and Activities ($2.8 Million)

A. A national Joint Council

To coordinate efforts and mobilize support of science, mathematics, education, business, industry, and labor for the improvement of mathematics, science, and technology education (MS&T)

B. State Joint Councils

Work with the national group to utilize state resources and coordinate state efforts

C. National Center for MS&T Education

Materials and instructional R&D under oversight of Joint Council

D. National MS&T Information and Computer Program Data Bank and Interchange

III. Support Programs for Critically Needed Mathematics, Science, and Engineering Personnel ($23.5 Million)

A. Precollege MS&T leadership

1. Presidential awards for teaching excellence
2. Presidential MS&T teacher fellowship program (one year or up to three summers; salary matching)

B. Development of excellence

1. Presidential undergraduate faculty development fellowships for college and university teachers
2. Summer institutes for precollege teachers in critical fields
3. Presidential student scholarships in critical fields ($2,500 per year for 1000 students each year, renewable)

IV Programs to Link Mathematics, Science and Engineering Education and Basic Research ($6 Million)

A. Research participation

1. Teacher research participation in universities
2. Teacher research and research application participation in industry
3. Preservice ~~teacher~~ undergraduate research participation in universities and industry
4. High school research projects

V. Resource R&D for Precollege MS&T Education ($20 Million)
    A. Course Content Development
    B. Instructional Laboratory R&D; Instrumentation and Methods
    C. Microcomputer and Advanced Technology Utilization
    D. Search for Excellence and Dissemination of Outstanding Examples in MS&T Education

VI. Resource R&D for Undergraduate Mathematics, Science, and Engineering Education ($30 Million)
    A. New Laboratory Instrumentation
    B. Computer and Advanced Technology Utilization
    C. Research Development and Demonstration on Classroom and Laboratory Practice

VII. Mathematics, Science, and Engineering Education in Support of Research and Economic Recovery ($20 Million)
    A. Science-based Technician Training (Community Colleges)
    B. Engineering and Technician Retraining

VIII. Public Awareness and Youth Motivation Program ($10 Million)
    A. Public TV Programing in MS&T and Society
    B. Secondary School Mathematics, Science, and Engineering Clubs
    C. Special Programs for Women and Minorities on MS&T Careers

IX. Research in Mathematics, Science and Engineering Education ($10 Million)
    A. Applications of Learning Research
    B. Research on Technology Utilization in MS&T Education

- C. Research on Scope, Sequence, and Discipline Articulation for Precollege MS&T Education

X. Pre and Post Doctoral Support ($30 Million)

- A. Graduate Fellowships
- B. Post Doctoral Fellowships
- C. Senior Post Doctoral Fellowships

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February 21, 1983

Senator Jake Garn
(c/o Wallace Berger)
Chairman
Sub-Committee on HUD-Independent Agencies
Committee on Appropriations
U.S. Senate
1241 Dirkson Senate Office Building
Washington, D.C. 20510

Dear Senator Garn:

In an effort to keep the scientific, mathematical, and science education communities fully informed about plans for the $15 million NSF science education initiatives of the current fiscal year, your staff made available to me and others copies of your letter of February 17, 1983 to Dr. Knapp, Director of the NSF. Before offering comments and recommendations, I want to express strong endorsement of this gesture of openness in communications with those directly affected by NSF science education programs.

Your letter to Dr. Knapp is a remarkably thoughtful and accurate assessment of the situation and of directions which should be taken to address the crisis. With careful and appropriate specification and rapid implementation, your recommendations can help the NSF take those initiatives that are needed.

We recognize that there has been a perception that the science education community lacked consensus on what should be done to resolve the problems NSTA and others have documented. Recently, presidents and executive officers of the National Science Teachers Association, the American Association of Physics Teachers, the National Assocation of Biology Teachers, and the National Assocation of Geology Teachers formed a group called the Council of Science Teaching Associations. As Interim Director and Secretary of this council, I have been authorized to represent these associations on certain agreed upon matters involving science education. The enclosed testimony, which I authored, illustrates the scope of that agreement. The education division of the American Chemical Society is also represented on our Council, although I am not permitted officially to represent their views.

The Council of Science Teaching Associations represents science teachers, science administrators, science educators, and teaching scientists at all levels. Thus the council is fully representative of the subject matter disciplines--physics, chemistry, biology, and geology--at colleges and universities, as well as science teachers in these fields in elementary and secondary schools. Council organizations also include local science supervisors, state science supervisors, as well as those in schools of education who train science teachers. No other organization or group either includes this representation or reflects our views on the professional aspects of science education accurately. Given the fact that there had not yet been any communication between you or your staff and representatives of our Council, we are surprised and enormously pleased with what you say in your letter to Dr. Knapp.

Beginning with the second paragraph of page two of your letter, through the next to the last paragraph on page three, you provide a succinctly stated and superb description of what should be the science education programs at the NSF. The congressional authorizations committees should consider incorporating this language into their 1984 authorization legislation for the Foundation.

In the first paragraph on page two of your letter, and in your "P.S." on page three, you approach the very difficult task of differentiating reponsibilities of the NSF and the Department of Education for science education. Your comments about "...a merit selection process..." and the "...fine scientific tradition..." at the Foundation, in contrast with a Department of Education which would "...direct its considerable resources..." toward "...what will, in effect, be a formula grant program...", reflect concerns which we have expressed strongly in our testimony. Let me comment first on this general problem and then offer some suggestions for differentiation of reponsibility for science education between the two agencies.

Even though we have been strongly critical of the Department of Education on the basis that funding decisions were being affected by political and ideological considerations to an extreme, that concern has now been largely removed. The Administration as well as the Secretary of Eduation want efficiency and high quality in ED programs. The recent appointment of Manuel Justiz as Director of NIE is very encouraging. He is determined to restore high quality and integrity to program management and panel review at the NIE. Thus we may now expect programs of high quality there, judged and awarded on merit.

The Department of Education, through grants to State and Local Education Agencies, and through programs at NIE, can play an important role in addressing the science education crisis. In both the Administration's initiative for 1984 and in HR 1310, funds are provided to address the science and math teacher shortage. Several states also have programs to increase the supply of such teachers. You are therefore correct in suggesting that NSF's limited resources not be used mainly for teacher training programs. As a general principle, we would agree that pre-service training of science and mathematics teachers should be mainly a state and local responsibility, although in times of crisis, state and local funds should be augmented by federal support through the Department of Education. We would further agree that routine and continual in-service education programs for science and math teachers should be a local responsibility. But, again, in times of crisis, funding should be augmented by federal support through the Department of Education. The private sector should focus mainly on local and community assistance through provision of matching funds, resources, and personnel.

In educational research, we believe that the NIE should be principally responsible for basic research on learning and on the use of various technologies to facilitate learning. The NSF should be responsible for research on the structure of course content in science and mathematics fields as well as research on the applications of basic research in learning science and mathematics that would result from NIE supported research.

Curriculum research, which would focus on selections of content and sequence, K-16, should be a responsibility of the NSF. But the actual curriculum--that is, the selection of content and decisions on sequence must be a local and state responsibility.

We share your view that science and mathematics course content improvement should be done through NSF programs. We strongly agree with the second paragraph of page two of your letter. What you say is strikingly similar to words I used in testimony before Represenative Fuqua's Committee on Science and Technology on February 16, 1983:

> "We desperately need national course development efforts with teams of scientists, science teachers, and science educators and learning specialists, working in cooperation with publishers, equipment manufacturers, and computer and software companies. These course development projects should design courses with applications and labs that use modern micro-electronics and computers."

Rather than try to develop course content in each of the 16,000 school districts of the U.S., which would be wasteful and inefficient, and for which we could never assemble the needed concentration of expertise, it is important to have national efforts. The local schools can build their curricula by selecting and sequencing from among a variety of high quality and appropriate alternatives. National efforts have the benefit of widespread involvement of thousands of teachers in field trials and evaluation, assuring local school input into alternatives which are produced. Local schools also can adapt nationally produced materials for their special needs.

In paragraph one on page three of your letter you make reference to one of our projects at NSTA, our Search for Excellence in Science Education. You should know that the NSF Commission has provided partial funding for this project. In some of our preliminary analyses of centers of excellence, we have discovered important information about the teachers who have been leaders in creating excellent programs. Their average age is 51, and they have been teaching 17 years. These were the people who began their careers immediately after Sputnik and who participated most heavily in NSF institutes and projects.

If NSF is to build leadership and concentrate on meritorious programs, the 1983 funding initiatives must increase the size of this leadership pool. Thus, there should be a program component aimed at providing support for our best science and math teaching personnel to participate in conferences, workshops, institutes, and advanced degree programs. Then the Department of Education block grant program can provide in-service education for the marginally prepared teachers and scholarships and loans to bring bright energetic young people into science and mathematics teaching.

Using as a framework the excellent recommendations of your letter, let me offer a specific set of program activities for the 1983 NSF Science Education Initiatives. I will include some comments and rationale where appropriate:

Presidential Awards for Teaching Excellence $1.1 Million

This program, as proposed by the Reagan Administration, and as described in the NSF draft guidelines, is valid and important. A major problem facing science and math education at the secondary level is the poor image of teaching. Identifying excellent teachers and having the President of the United States recognize those teachers with an award presentation in the Rose Garden would have a profoundly positive effect on that image. If the program receives quick approval, these awards for 1983 could be made before the Fall, helping to publicize the importance of science and math teaching, and stimulating many young people to enter science and math teaching programs at colleges and universities. It would also help stem the tide of persons leaving the profession, and would help identify science and math leaders in the schools.

Pre-College Science and Mathematics Leadership Program

Pre-College Chautauqua-Type Short Courses Program	$1.2 Million
Pre-College Science Faculty Fellowship Program	$2.1 Million
Pre-College Summer Faculty Fellowships Program	$2.2 million.

These three highly focused programs would select teachers strictly on merit. The Chautauqua program would be modeled after the AAAS program for college teachers, except that stipends of $100 per day would be provided. Teachers would come to a course center for two days in the Fall, be given an interim assignment, then return for two days in the Spring. The $1.2 million would cover all costs, including program administration. Twenty course centers and 500 teachers could be served. The Science Faculty Fellowship program would select promising and capable teachers, on merit, with salary matching stipends of up to $12,000, plus tuition, books, and materials. One hundred fellows could be selected to pursue one year of advanced study. Summer science faculty fellowships would provide advanced study for 500 teachers at 20 centers, for an average of 8 weeks each. Stipends of $300 per week would be paid. The proposed budget covers all costs associated with such a program.

These personnel programs would directly benefit 1204 of our best and brightest science and mathematics teachers at the pre-college level. Since there are about 200,000 such teachers, this would create a pool of leaders consisting of the top 0.6 percent of the pre-college science and mathematics teachers in the United States.

Pre-College Course Content Improvement Program

Course Development Program	$2.9 million
Computer Utilization Program	$1.0 million

These two programs would receive competitive proposals for revising and improving course content in physics, chemistry, biology, and earth science in grades 7-12. Funding would be provided mainly for first phase activities for planning, organization, and initial production of prototype materials. Subsequent funding would be from 1984 appropriations for those projects which demonstrated greatest promise. Emphasis would be on practical applications, modern micro-electronics, and the computer.

Public Awareness and Motivation Program $1.5 million

This program would support public TV programming (like 3-2-1 Contact, which NSTA has officially endorsed), museum programs for youth and adults, etc. This low level of funding would permit only first phase prototype development in fiscal 1983. Then promising projects could have greater funding in fiscal 1984.

Search for Excellence in Science Education Program $0.5 million

This small program component would continue the NSTA search for excellence, including provisions by which centers of excellence can carry out evaluation documentation for the National Diffusion Network of the NIE.

NSF/NIE Joint Program Review Panel $0.5 million

This review panel would be appointed with an equal representation by the directors of NSF and NIE. It would function in a manner similar to the existing JDRP for the National Diffusion Network of the NIE. It would concern itself only with evaluation of science and mathematics programs (like those identified in the search for excellence project). Programs judged meritorious would be disseminated through the NDN.

Science Education Research Program

Applications of Cognitive Research	$1.0 million
Technological Instructional Model Research	$1.0 million

These two program components would provide the applied research base for improving science and mathematics teaching. Again, funds for 1983 would provide first-phase research funds for numerous projects, from which the best could be continued on the basis of early phase performance. Research on technology could include automated classroom management, large group instruction through computer demonstrations and simulations, etc.

We recognize that recent criticisms of NSF science education programs centered on "proliferations of low funded activities which could not be expected to produce significant results." Given the highly focused program components suggested here, in areas of high leverage, and with the limitation of first-phase funding, the $15 million of 1983 funds can give a substantial start toward improving pre-college science and mathematics education.

It is essential that congressional approval for these or other 1983 programs be given immediately, so that NSF may move rapidly to solicit proposals and announce fellowships and institutes. With the NSF Director's support, there is no reason why these or similar programs cannot be instituted within two months, so that some activities can begin as early as this summer, and others can begin in the Fall. To delay beyond the Fall should be unacceptable to all of us who want action in addressing the crisis.

Thank you again, Senator Garn, for your fine letter, and for you understanding of, and support for, science and mathematics education.

Sincerely,

Bill G. Aldridge

Bill G. Aldridge
Executive Director
National Science Teachers Association
Interim Director,
Council of Science Teaching Associations

CC:Dr. Edward A. Knapp, NSF
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United States Senate
COMMITTEE ON APPROPRIATIONS
WASHINGTON, D.C. 20510

FILE

February 17, 1983

FILE

Dr. Edward A. Knapp
Director
National Science Foundation
Washington, D.C. 20550

Dear Dr. ~~Knapp~~ Ed:

Shortly after your January 24, 1983 submission of the Foundation's "Program Plan for Improvement of Precollege Education in Mathematics and Science", I distributed copies of the report to knowledgeable individuals in the educational community. As a result of their review and our independent analysis, we find that the plan, as proposed, is not acceptable.

At a very fundamental level, the Subcommittee takes exception to the objective contained on Page 3 of the NSF report. These goals are construed in such a narrow manner as to preclude consideration of the broader objectives of a national science educational program by focusing on one component, i.e. teacher training. On the other hand, the NSF Commission has adopted a set of goals which broadly encompasses the scope of science education as follows:

- "To continue to develop and to broaden the pool of students who are well prepared and highly motivated for advanced careers in mathematics, science and engineering;
- To widen the range of high-quality educational offerings in mathematics, science and technology at all grade levels, so that more students would be prepared for and thus have greater options to choose among technically oriented careers and professions; and
- To increase the general mathematics, science and technology literacy of all citizens for life, work and full participation in the society of the future."

The Commission also correctly identifies the inadequacy of equipment and facilities, the failure of coursework to reflect the needs of tomorrow, and the need for new instructional technologies and approaches as major problems relating to the decline in student participation and achievement in mathematics and sciences.

Based on the legislative proposals recently transmitted by Secretary Bell, which directly addresses the teacher training issue, and the traditional roles of NSF versus the Department of Education, it would appear that the nation would be better served if NSF concentrated its limited resources in those non-training programs that are compatible with a merit selection process and that the Department direct its considerable resources supporting teacher training. Under this division of responsibility, the Foundation would provide the technical and scientific expertise needed to support an effective national science education program including teacher training.

The specific function that we believe are appropriate for NSF are: materials development; public awareness and motivation; teaching and materials demonstrations; evaluation of materials and teacher training; research in learning and cognition; and high technology applications. A brief description of each of these areas follows.

There is a general recognition that the subject matter which is taught in our schools is increasingly out of date. An initial priority would be to get widespread agreement on what ought to be taught in precollege (K-12) science and mathematics education. Until agreement is reached, it is premature to focus on upgrading existing teachers of science and mathematics. The development of school mathematics and science instructional programs and resources -- including text materials and computer software -- through collaborative projects involving mathematicians/scientists, educational researchers, publishers and program/software developers would also be a significant payoff area for NSF.

The problem with scientific literacy, as well as the proportion of students electing to pursue higher education in science, does not spring full-blown at the high school or college level -- it is in one sense a motivational problem. The problem starts at the elementary grades, where teachers are least prepared to teach science, and where States are least rigorous in setting standards for science curriculum and for certification of science teachers. Therefore, it makes little sense to treat secondary mathematics and science as an isolated problem; improvements at the secondary level need to be coordinated with efforts to improve teaching and curriculum at the elementary level as well. Furthermore, the issue of exposing students to science and motivating students at the lower grade levels is necessary for any science education program to achieve its maximum impact. As President Reagan noted in his State of the Union message, children must be reached before the age of 16 if they are to have a serious chance at a career in science or technology. As important as training secondary school teachers is providing them with students motivated to learn science and mathematics. Although there are real limitations in what the Federal government can do to motivate students, I believe that a true national educational impact can be achieved through both the schools and also by reaching children in their homes. The development and airing of quality television programs is an example of motivational techniques that would require a Federal investment and NSF is the logical agency to take the lead role.

The NSF should also support the development of teaching demonstration programs. The development and testing of teacher training programs for teachers already in the teaching force -- through the specific application of effective teaching and school research to the substantive areas of mathematics, the sciences and technology education should be a high priority. These demonstrations could focus on innovative and more effective methods of both improving subject matter expertise, as well as on improving teachers classroom instructional skills, especially with regard to the new subject matter they're learning. For example, the National Science Teachers Association is working to identify illustrative school programs in the sciences and the factors that contribute to their effectiveness.

The Foundation should also take the lead role in evaluating materials as well as existing training and proposed training programs. This would provide a "third party" verification of the effectiveness of materials developed elsewhere as well as training programs sponsored by the Department of Education.

The Foundation needs to undertake a vigorous applied research program to identify findings from cognitive research which have implications for precollege teaching and learning. Such research should focus on both the traditional teacher/student model and learning situations involving technologically advanced instructional models. As the Office of Technology Assessment states, "much remains to be learned about the educational and psychological effects of technological approaches to instruction".

There is also a need to develop a better understanding of the effects of incorporating technology into the traditional secondary school curriculum. Federal support for investigations, through NSF, should be part of any national science education plan. Emphasis should be given to using computer technology to aid precollege mathematics and science education programs. This technology offers characteristics of economies of scale in cost and time, and also addresses the issue of student motivation. Satellite transmission, computers, video disks, video tapes and the rest are not magic, but they do provide ways and means of reaching teachers and students with information that is up-to-date, accurate and effectively presented. Lots of systems are possible, but the point is that NSF should take a lead role in reaching teachers using high technology rather than through traditional summer institute or workshop.

If NSF were to undertake these programs, it would become the lead agency in advancing the State-of-the-Art in science education, as it has historically been in other fields. With these thoughts in mind, we request NSF to revise its plan accordingly and refrain from obligating science education funds until such a plan is approved by the Committees.

Sincerely,

Jake

Jake Garn
Chairman
HUD-Independent Agencies
Subcommittee

P.S. Ed -- I am quite concerned that we develop a set of activities for NSF that will be in keeping with the Foundation's fine scientific tradition and avoid duplicating what will, in effect, be a formula grant program funded through the Department of Education.

NATIONAL COUNCIL OF
Teachers of Mathematics

NCTM

President
Stephen S. Willoughby
13 Dingletown Road
Greenwich, Connecticut 06830
203/869-1932

5 April 1983

Senator Claiborne Pell
Senate Office Building
Washington, D.C. 20510

Dear Senator Pell:

Senator Stafford has forwarded your questions regarding S. 530 and other matters to me. My responses follow.

1) Nobody really knows why the SAT scores have fallen the way they have, but on the basis of available information and informed speculation, I would guess the reasons include the increased influence of television (and corresponding decrease in attention span and willingness to stick with a thought process for a reasonable length of time without immediate entertainment), increased use of drugs (including alcohol and tobacco), doubt in the minds of people (young people in particular) about the future existence of the world and therefore in the need for them to prepare for their own future, changing values of society and young people that put less emphasis on "success" as measured by previous standards and more emphasis on "self-fulfillment" (in many, but not all, cases, this seemed to me to be little more than a synonym for short-term selfishness), and the fact that a wider range of students was taking the test. These factors in society tended to put pressure on the schools to entertain rather than educate, and to try to encourage children to think they had succeeded when they had achieved nothing. Textbooks adopted by schools have become easier and easier, both for the teachers to teach from and for the pupils to appear to have learned from. By providing very little content, the textbooks encourage both pupils and teachers to believe they have accomplished something when in fact they have not.

In responding to your question, it is important to note that every reason I have proposed, and every reason I have heard proposed by others, would be expected to affect mathematics scores at least as much as verbal scores, and yet verbal scores fell faster and further than mathematics scores. The only obvious difference that might account for this difference on the national level is the great emphasis on mathematics and science that occurred in the 1960's through NSF institutes, curriculum development projects, and so on.

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On the basis of recent test results, it would appear that the trend has already been reversed, especially among lower achieving students and minorities. Unfortunately, most of the improvements in recent test scores seem to be at the lower range of intellectual abilities (knowledge, skills, simple understandings as opposed to deep understandings and applications, etc.). Since we now have computers and calculators that can handle the lower order intellectual activities much more efficiently than any human, there is some doubt that the apparent reversal is going to be a useful one. In any case, the need is certainly far outstripping the supply for well-educated people.

I believe the efforts to reverse this trend should be concentrated primarily on providing better teachers and giving those excellent teachers who are still teaching greater support to do an excellent job. This requires more societal support (financial support, support in matters of discipline, more respect for teachers and education generally, and so on), higher standards for becoming a teacher, administrators who have time and inclination to lead in the efforts to improve education, longer time spent on education (longer school days and longer school years -- probably requiring the air-conditioning of many schools), better procedures for choosing textbooks (publishers who produce good textbooks usually find it very difficult to sell them because criteria used usually involve the "thumb-test" to see if it looks different or difficult, copyright date, and the personality of the sales representative rather than the simple question of what evidence there is as to whether the textbooks provide better education). Beyond all of these specific issues, we as a society must decide what it is we want the schools to do -- is the main business of the schools supposed to be education, or are the schools to be used to solve all of society's problems from birth control to death education, including providing substitute parents for children of working parents and food for the undernurished? There are many noble goals for which the schools can be used, but each new commitment reduces the emphasis on quality education.

2. The average person now teaching mathematics probably can't be educated to the point that he or she will be able to teach the courses you mention. There are some excellent teachers now teaching higher-level mathematics and computer science courses, and there is a small number of excellent teachers who could teach those courses with a bit more education. However, a certain minimum quantitative intelligence and interest is needed for this kind of teaching and a bit (or even a lot) of extra training through in-service programs is not likely to prepare very many of today's teachers to teach advanced mathematics courses. In so far as such in-service courses DO prepare present day teachers so they can do a good job on advanced mathematics courses, they will also prepare them to be much more attractive to industry, and they will simply leave for higher pay, better conditions, and the greater respect they will get elsewhere.

During the 1950's and 1960's we chose the best school teachers we could find, gave them a still better education, and from my personal experience, I would say that more than half of them left teaching within five years to go into college teaching, industry, or government.

3. Certainly as much emphasis is needed at the elementary school level as at the secondary school level, especially in mathematics. Mathematics is needed to learn more mathematics because of the sequential nature of this subject, but it is also essential to all of the sciences, including the social sciences. The techniques should probably be different at the elementary school level than at the secondary level. At the secondary level it is possible to reach a rather large portion of the teachers of mathematics and science with a fairly small cost. As long as every elementary school teacher teaches mathematics, the cost of reaching them all will be substantial. Instead, efforts might reasonably be directed at principals, supervisors, or mathematics specialists. Another possibility is to set up programs to help two teachers per school with the condition that the administration and other teachers agree to let those two teachers provide leadership and education in mathematics when they return (and, or course, you would want to require them to return and provide such leadership and education).

The questions you addressed to other people are sufficiently interesting so that it takes great will power on my part not to answer them also, but I suspect you can pretty well guess my answers to most of them on the basis of my comments above. However, I must simply comment that the merit scholarships proposed in H.R. 1310 are not even approximately adequate. To be effective, such scholarships should begin in the first year of college, should be available for up to five years, should include sufficient money to cover tuition, living expenses, and some incidentals, and should certainly require education courses as well as good solid content courses. Without these conditions, you will attract few, if any, new teachers and recipients will have no incentive to go into teaching (they'll be able to pay off the total loan with one month's salary in industry). Beyond that, 300 new mathematics and science teachers a year would not even provide enough replacements for one of our larger cities -- let alone the rest of the country.

Thank you for the opportunity to respond to your very thoughtful questions.

Sincerely,

Stephen S. Willoughby

SSW:wvw

c: Senator Robert T. Stafford

COPY

NATIONAL COUNCIL OF
Teachers of Mathematics
NCTM

President
Stephen S. Willoughby
13 Dingletown Road
Greenwich, Connecticut 06830
203/869-1932

5 April 1983

Senator Christopher J. Dodd
Senate Office Building
Washington, D.C. 20510

Dear Senator Dodd:

Senator Stafford has forwarded your questions regarding S. 530 and related matters to me. My responses follow.

1) I don't have the statistics you asked for regarding time spent teaching mathematics and science in elementary schools of other countries. I have asked Richard Long of our staff to try to get such information for you and also to see if he can get relative information about compensation for teachers in the various countries. You should hear from him within a few days.

2) Since mathematics is a sequential subject, any failure to learn sufficient mathematics will adversely affect a student's ability to learn mathematics subsequently. Thus, lack of learning, or inappropriate learning in the early grades will have a major negative effect on all subsequent mathematical learning. Beyond this, any science that is taken seriously as a science, including the social sciences such as economics, requires a substantial amount of sophisticated mathematics. Thus, our failures in elementary school mathematics can be expected to show up in weak mathematics and science learning in high school and in college.

While it is clear that inadequate time devoted to learning mathematics in the elementary schools limits the positive results that can come from such education, it is also true that teaching inappropriate mathematics at that level can cause severe damage as well. Latest figures from the National Assessment of Educational Progress continue to confirm earlier figures that suggest that our young children are good and improving on precisely those mathematical tasks that can be done more efficiently by a $10 calculator or a slightly

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more expensive computer. As well as spending more time teaching mathematics in the elementary schools we must give considerable attention to WHAT we teach and WHO is doing the teaching and what sort of education such teachers have.

I hope this is of some help to you. Thank you for the opportunity to respond to your interesting questions.

Sincerely,

Stephen S. Willoughby

SSW:wvw

c: Senator Robert T. Stafford

COPY

NATIONAL COUNCIL OF
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T M
President
Stephen S. Willoughby
13 Dingletown Road
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203/869-1932

19 March 1983

Senator Robert T. Stafford
SD-428 Dirksen Senate Office Building
Washington DC 20510

Dear Senator Stafford:

Thank you for your letter of March 10 and for the opportunity to provide testimony before your Subcommittee.

In response to your question about the Levin-Rumberger piece from the Washington Post, I must start by mentioning that although economists are increasing the quantity and sophistication of the mathematics they use, they have occasionally been known to be wrong in their projections. Indeed, 25 years ago some economists were predicting that by 1984 we would have a very small working class made up of engineers, technicians, and mathematicians. The vast majority of the population would become the new leisure class, since machines would handle all of the menial tasks previously done by janitors, nurses' aids, orderlies, kitchen helpers, and so on.

Suppose, however, that Levin and Rumberger are correct in their predictions that relatively few new "high-tech" jobs will be created. Representatives of business (see the 1982 survey by the Center for Public Resources, for example) and of the military are complaining NOW about the lack of mathematics and science skills of the people filling their least advanced jobs (janitors, secretaries, enlisted soldiers, etc.).I see no reason to suppose that this condition will change without a major improvement in pre-college education. Given the stakes with which we are playing (the economic and military security of the nation), I must say that I believe that it would be better to have well educated citizens in the future and not need them than it would be to need them and not have them.

The key phrase in the Levin-Rumberger piece is "Workers will need to learn different skills ..." so that people trained today for the technology of today or even that of the near future will find their skills becoming obsolete long before they reach middle age. What we need is education for a changing world -- we must teach all students to solve real problems, to adapt to new situations, to think. And, in order to do this we need excellent teachers of mathematics, of science, of vocational education, and of other subjects. Present conditions and projections make clear the fact that both the quality and the quantity of mathematics teachers are inadequate now and are getting worse. Demographic projections show that this will soon

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be the case for elementary school teachers and shortly thereafter for teachers of all subjects.

In response to your second question, I have previously proposed tax credits for businesses that provide summer employment for teachers or who encourage their employees who are certified teachers to spend part time teaching in schools. Of course, as long as teachers' salaries and other working conditions remain as bad as they are, some penalty would have to be imposed on industries that hire such summer-employed teachers on a permanent basis. The various "adopt-a-school" plans that have received attention lately certainly provide some promise for improvement of those schools adopted. For years I have advocated that local citizens be encouraged to volunteer their services in schools as many now do in hospitals. The major flaw in all of these proposals is that they tend to work best in affluent communities where education is already better than average. We need ways to insure the improvement of education in all communities.

Mathematical deficiencies of students are, in my opinion, a result of many factors including:
(a) increasing emphasis on non-academic activities such as television, arcade games, etc. throughout our society;
(b) uncertainty about future life on earth (and therefore a certain lack of committment to one's own future);
(c) decreasing competence and committment of teachers; and,
(d) inappropriate curricular emphasis in schools. There has been a tendency in mathematics, as well as in other subjects, to discourage concentrated, extended thought -- anything that does not come easily and quickly is not considered to be worth the effort. This fostering of short attention spans is particularly unfortunate in sequential subjects such as mathematics. Stronger teaching and supervisory personnel would be more inclined to choose textbooks that encourage deep, concentrated, flexible thought on the part of students and teachers -- it is the quality of educational personnel that will determine the speed and magnitude of curricular changes.

In answer to your last question, I don't believe it is realistic to expect local communities to make major sacrifices to solve what is obviously a national problem without some incentive from the federal government. The key step that I propose is doubling the salary of every teacher in the country. This would require about 40 billion dollars per year of new money. I suggest that this be provided in matching funds so that the federal government would supply about two-thirds of the new money and local and state governments would be expected to supply about one-third of the new money (for a total of two-thirds of the entire salaries of teachers). Appropriate conditions for obtaining the matching funds should be strong standards for becoming and remaining a teacher and a minimum of 220 days in the school year.

If these steps were taken, many of the conditions in schools would improve naturally because it would no longer be economically feasible to misuse the time of professional teachers. To encourage still further improvement, citizens of local communities ought regularly to examine conditions within the schools with a view to making the schools more efficient and pleasant places to learn and teach.

I believe the federal role in all of this ought to be to provide matching funds for teachers' salaries with simple conditions regarding the length of the school year and standards for becoming and remaining a teacher. If anybody is seriously interested in this proposal I'd be delighted to provide more details.

I believe that a long-term serious solution to the crisis in education requires a major national committment of the sort proposed above. However, if the political realities of the moment prescribe a limited committment of only 400 to 500 million dollars per year for two or three years, it would be possible to do some good if such funds were used wisely.

One constructive use of such funds would be to create a substantial number of scholarships to be awarded on the basis of pure merit for prospective mathematics and science teachers. Such scholarships should provide full tuition and fees plus reasonable living and incidental expenses for up to five years. Then, the recipient should be required to teach for at least one year for each scholarship year. If the stipend is large enough this may be sufficient incentive to discourage recipients from taking higher paying jobs and paying back the scholarship.

A second possibility is to provide summer institutes for elementary school teachers, supervisors, and principals. One advantage of concentrating on elementary school personnel is that such teachers usually have weak enough mathematics backgrounds so they do not automatically become very attractive to industry when they improve their skills -- when such institutes are made available to secondary school teachers there should be some requirement that the individuals return to teaching in the schools from which they came for at least a year. Probably the optimal effect of such institutes would be obtained if two people per school attended the institute with the requirement that when they returned to their schools they would provide inservice help for the rest of the faculty who would have committed themselves in advance to accepting such help.

If money is to be spent to recertify teachers of other subjects to teach mathematics and science great caution should be exercised in setting standards. Simply satisfying state minimal requirements is not sufficient since those requirements are, indeed, usually minimal. For example, I was recently told that a New York City contract for recertifying teachers to teach mathematics was awarded to a local community college. Can you imagine the public outcry if the local community college were awarded a contract to retrain proctologists to be brain surgeons? Since the most advanced New York State mathematics requirement is one year of calculus (usually a freshman course) the community college will no doubt be able to satisfy the letter of the law without being able to offer any upper class mathematics or education courses, but nobody could seriously suppose that the products of this sham will be qualified to teach high school mathematics.

Thank you for the opportunity to testify and to provide these further comments. If there is any other way I can help you carry on your important work please let me know.

Sincerely,

Stephen S. Willoughby

Stephen S. Willoughby

WASH. POST 1/30/83

INSI

High-Tech Requires Few Brains

The jobs being created will demand less skill, not more

By Henry M. Levin
and Russell W. Rumberger

MUCH IS BEING MADE of our arrival into the age of high-technology. In Massachusetts last week, President Reagan declared the country is "in a great transition" to high tech, furthing the notion that the nation's economic ills will be cured by our new sweetheart industry as it spawns massive numbers of new jobs requiring sophisticated mathematical and engineering training while reducing or even eliminating opportunities for the unskilled.

Well, the evidence suggests it isn't going to work that way.

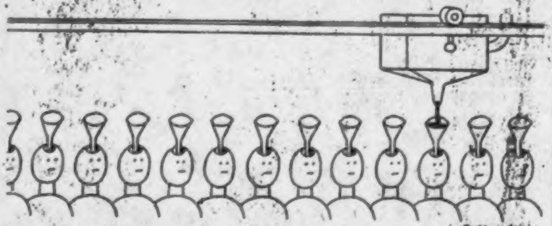
High tech is neither the place where most new jobs will be found nor will high tech require a vast upgrading of the skills of the American labor force. To the contrary, the expansion of the lowest-skill jobs in the American economy will vastly outstrip the growth of high-technology ones. And the proliferation of high-technology industries and their products is far more likely to reduce the skill requirements for jobs in the U.S. economy than to upgrade them.

Last year the Labor Department did project that in the '80s, jobs for computer programmers would grow between 74 and 148 percent while overall job growth would only be 22 percent.

But the percentages are misleading. The total number of new jobs for computer programmers is expected to be 150,000. Some 1.3 million new jobs are projected for janitors, nurses' aides and orderlies. That's nine unskilled jobs in these categories alone for every computer programmer. In fact, no high-tech job even makes the Labor Department's top 20 in terms of total numbers of jobs added to the U.S. economy.

New jobs for data-processing-machine mechanics will increase 148 percent, the fastest growing job category. But that large gain translates into an increase of less than 100,000 new jobs, while 800,000 new jobs are projected for fast-food workers and kitchen helpers alone.

Of course, occasional shortages of skilled workers will arise in particular occupations and industries as they have occurred historically. Both the economy and educational system will have to make specific adjustments to alleviate them. But that is hardly the general shortage of skilled workers projected by those who have exaggerated the effects of high-tech.



By Mario [illegible]

Neither will the high-tech transformation of existing jobs create demands for increasingly sophisticated work skills. Secretaries will work with word processing equipment; bookkeepers will use computerized, financial spread sheets; purchasing and inventory clerks will apply computerized record systems; mechanics will use diagnostic equipment employing minicomputers; telephone operators will rely on computerized directories.

But there is little evidence that these jobs will require workers with more sophisticated skills. To the contrary, studies suggest that the new technologies provide opportunities to further simplify and routinize work tasks and to reduce the opportunities for worker individuality and judgement.

In such diverse areas as office work, data processing, drafting, wholesale and retail trade, and computer programming, microcomputers are making it possible to utilize persons with lower skills to perform highly sophisticated functions.

Using computers does not necessarily require computer skills. For example, the new generation of office computers is specifically designed so that "no special computer skills are needed." The latest word processors can even correct typing errors automatically by the use of electronic dictionaries, so letter-perfect typing and strong spelling skills are no longer required.

As computer languages have become more "user-friendly" and sophisticated software has become [redacted] graded in terms of their skill requirements.

In fact, the use of sophisticated equipment often means that the worker requires less sophisticated skills. Today's Ford Escort is far more sophisticated than the Model T of 50 years ago. Yet it is far easier to drive today's vehicle. Computers are far more sopisticated today than they were 10 or 20 years ago. Yet the average programming task is considerably less demanding than it was when there was the need to reprogram plugboards and work in machine languages.

Workers will need to learn different skills rather than more demanding ones. Certainly word processing is different in some respects from typing. However the new skills needed can be acquired through on-the-job training. An expanded foundation in science, mathematics, and computer programming is hardly necessary.

We see an entirely different set of problems arising from high tech than is popularly assumed. Not only will the economy create more low-skill jobs than high, it is possible that high tech will eliminate far more jobs than it will create. For example, experts suggest that the use of computer-assisted design (CAD) software may eliminate a majority of the 300,000 drafters in the U.S.

If the future of work is being written in Silicon Valley, the danger signs are already evident. Although there are clearly some high-level executives, programmers, and engineers who are stimulated by their jobs in the Valley, most workers in these industries are clerical employes, assembly workers, and low-level technicians the challenges of whose labor may leave something to desired.

A recent front-page story in The San Jose Mercury estimated that a third of all workers in the Valley are involved in drugs and alcohol and that drugs are largely responsible for [redacted] look at the job implications of high technology, rather than blindly accepting the folk wisdom on the subject.

Henry M. Levin is director of [redacted] *search economist at, the Institute for Research on Educational Finance and Governance at Stanford University.*

CALIFORNIA
MICROWAVE

March 24, 1983

Mr. David Morse
SD-428 Dirksen Senate Office Bldg.
Washington, D.C. 20510

Dear Mr. Morse:

Enclosed is my response to the questions in Robert T. Stafford's letter of March 10, 1983.

Sincerely,

David B. Leeson

Dr. David B. Leeson
President

DBL/rm

Enclosure

55%

CALIFORNIA MICROWAVE, INC. 990 ALMANOR AVE. SUNNYVALE, CA 94086 (408) 732-4000 TWX 910 339-9231 TELEX 35-6018

David Morse
SD-428 Dirksen Senate Office Bldg
Washington, D.C. 20510

Dear Mr. Morse:

The following comments are in response to the questions forwarded to me with Senator Stafford's letter of March 10, 1983.

Q 1. A recent Washington Post Op-Ed piece, which I have attached, suggested that the vast majority of new jobs in the 1980's and 1990's will not require extensive upgrading of technological skills, and that the greatest labor market needs will be in the area of relatively unskilled jobs.
a. Would you comment on this projection?

A: The authors of this article ignore two important facts:
(1) Each engineer creates jobs for approximately 25 other workers throughout the economy.
(2) Traditional industries cannot be revitalized to provide jobs for other workers without the incorporation of high tech processes. Productivity will then depend on the availability of workers able to deal with the new technology. This ability does not come naturally; it requires training. To the extent that industries have to retrain every worker, productivity will be depressed.

Q 1.b. What do you feel the role of vocational training should be in the context of a Federal mathematics and science initiative?

A: Vocational training currently has only an indirect connection with math and science education. This is primarily a result of separate funding and, in some cases, separate counseling "tracks." However, as stated above, the workers of tomorrow will have to be competent users of high tech processes. Consequently, integration of math and science concepts with vocational education will be increasingly important. Besides policy guidance, the major role of the Federal government in vocational education has been and should continue to be the provision of financial assistance and incentives. This has two very important purposes: to permit career exploration and to provide training for employment.

Q 2. What do you suggest as an appropriate mechanism for increasing and improving the degree of private sector and local school district involvement in improving science and math programs?

A: AEA's emphasis has been on postsecondary education and has not included a study of the K-12 situation. Consequently, AEA has no formal position on this subject. However, a few comments can be made. Using industry people in the classroom is fine as a temporary aid but is not a primary, long-term solution. Content specialists are not necessarily good teachers. Interest and training are equally essential. In addition, retraining teachers in other fields such as English and social studies to teach math and science will simply exacerbate an already dangerously low quality situation. This also, therefore, is not an acceptable primary, long-term solution. Improving math and science programs at the elementary and secondary level cannot be left to industry; it is the primary responsibility of school districts and states, with the assistance of the federal government and of industry.

Q: You have stated that two of the reasons for a shortage of engineering faculty are low faculty salaries relative to industry and poor laboratory and teaching facilities. We have also heard in the past that qualified foreign engineers who wish to come to this country and teach may be precluded by our immigration laws from doing so.
Would you care to comment on this?

A: Current immigration law for a foreign teacher seeking to immigrate to the U.S. requires one to qualify as "an alien of exceptional ability," which is narrowly interpreted by the Immigration and Naturalization Service. This restrictive interpretation makes it difficult to import foreign faculty. The situation may worsen if immigration legislation pending in Congress passes. This proposed new law (S. 529 and H.R. 1510) threatens to cut off or severely reduce the number of foreign engineers admitted to the U.S. in two important respects. First, it may limit the engineers who have preference for admission to those with Ph.Ds or Einstein-type reputations. Second, the legislation includes a provision that all foreign graduates of U.S. universities must leave the U.S. for two years before they can reapply for admission. In response to protests to this provision, the section has been amended to provide for limited waivers for students in certain specified fields, including engineering. However, the Senate bill places caps on the number of waivers, and the House bill includes a sunset provision for the waivers.

Q: In terms of the engineering shortages and deficiencies which you have cited, is there anything that the Federal government should be doing, or that your industries should be doing, at the elementary and secondary level of education?

A: There is a long-term need for additional money for math and science education at all levels. Private industry cannot and should not be forced to underpin both higher education and K-12 education. Industry is not in the education business. Yet industry has already assumed some of the burden of supporting public as well as private universities. Advisory support by industry is desirable, but final finacial responsibility rests with the states. Unfortunately, many states have financial problems and cannot provide the necessary additional money. Financial assistance by the Federal government is thus of critical importance.

I hope these comments have helped to clarify our position. If you have further questions, please feel free to contact me or Pat Hubbard, Vice President, Engineering Education, at the American Electronics Association.

Sincerely,

David Leeson
President
California Microwave

CALIFORNIA
MICROWAVE

April 4, 1983

Mr. David Morse
SD-428 Dirksen Senate Office Bldg.
Washington, D.C. 20510

Dear Mr. Morse:

Enclosed is my response to the questions in Robert T. Stafford's letter of March 25, 1983.

Sincerely,

David B. Leeson/rm

Dr. David B. Leeson
President

DBL/rm

CALIFORNIA MICROWAVE, INC. 990 ALMANOR AVE. SUNNYVALE, CA. 94086 (408) 732-4000 · TWX 910 339-9231 TELEX 35-2019

Questions for: Dr. David Leeson
President
California Microwave, Inc.
Sunnyvale, CA.

Q 1. Statistics show that twice the number of graduating seniors (48%) living in the northeastern states had completed 3 years of mathematics compared to (24%) of those graduating seniors living in western states.

Why is there such a wide variance of mathematics achievement between these two regions? Do statistics such as this denote a need for a national standard of requirements for graduation?

A: A surprise to me; I can only speculate that the more established school districts of the east have a stronger tradition. Certainly guidelines but not standards can help.

Q 2. What does this mean as far as prospective job opportunities for the youth of these two regions?

A: To the extent they have mobility, I believe the eastern students will have superior job opportunities.

Q 3. To what extent are the new high technology industries influenced to locate within areas whose populace are known to be better academically prepared in the sciences?

A: Absolutely a key issue. This is why there are so many technology companies in Silicon Valley and along Rt. 128.

cape
COUNCIL FOR AMERICAN
PRIVATE EDUCATION
1625 Eye Street, N.W., Washington, D.C. 20006

(202) 659-0016
Robert L. Smith
Executive Director

March 25, 1983

David Morse
Subcommittee on Education,
Arts and Humanities
SD-428 Dirksen Senate
Office Building
Washington, D.C. 20510

Response to Questions from Hearing

Dear David:

1. As we said, in the first paragraph of our testimony, the crisis in verbal literacy, in reading and writing, is as serious as that of math-science. This is not as glamorous because it does not appear to be so directly related to the economic imperatives of an increasingly technological society. But a child who cannot read well or write clearly will have serious problems with every kind of learning, including math and science. Problem solving and the other higher order skills in all subjects depend on being able to read and write reasonably well. So we urge that we not "lose our balance" - that we consider all basic learning as vital as we develop legislation.

A case in point is foreign language education which some current bills include with math and science. A child is lost learning a foreign language if he cannot read and write English with reasonable facilty.

2. a) Legislation which supports teacher and student scholarships, tax breaks for companies which loan personnel or which hire personnel or which give equipment or which enter into collaborative efforts with the private sector should be as flexible as possible and not state-tied. Grants to encourage in-service programs, summer institutes, et al., should also be as flexible as possible.

b) Yes; if the funding is minimal, its uses should be maximized by funneling it through a minimum number of administrative entities.

c) I think it is most important that each community be given the creative opportunity to work out the programs which will be best. To try to determine the LEA's with the greatest need is a complex matter. If one goes by test scores, math-science money would probably tend to follow Chapter I money. But need is across-the-board; not only are disadvantaged students and schools in need of math-science help, but so are an enormous number of average and even above average students and the schools serving them. The problems of math-science education cover the entire spectrum of ability levels.

Members: The American Lutheran Church • American Montessori Society • The Association of Evangelical Lutheran Churches • Association of Military Colleges and Schools of the U.S. • Christian Schools International • Friends Council on Education • Lutheran Church — Missouri Synod • National Association of Episcopal Schools • National Association of Independent Schools • National Association of Private Schools for Exceptional Children • National Catholic Educational Association • National Society for Hebrew Day Schools • Seventh-day Adventist Board of Education, K-12 • Solomon Schechter Day School Association • U.S. Catholic Conference. Associated state organizations in Arizona, California, Connecticut, District of Columbia, Florida, Georgia, Indiana, Kansas, Maryland, Michigan, Minnesota, Missouri, Montana, Nebraska, New Mexico, Oregon, Puerto Rico, Rhode Island, Tennessee, Texas, Virginia, Washington, and Wisconsin.

David Morse
March 25, 1983
Page 2

I think that if there are going to be state formulas of some kind, thought should be given also to the general ideas contained in Senator Tsongas's bill according to which initiatives may be undertaken with the use of a 50/50 split of support from the Federal Government and from community or collaborating organizations. This pus a premium on diversity of effort, community committment, and flexibility.

3. I would urge that your bill be heavily committed to teach training of various kinds. The fact is that equipment is next to worthless if teachers do not know how to use it to teach. The computer is the prime example of a major instructional tool which relatively few teachers can use to teach more than rudimentary skills.

I hope there will be legislation which encourages industry to donate equipment. If this can be incorporated into the Senate bill, that is all to the good.

Improving math-science teaching at all grade levels - this must be the central focus. I hope the bulk of the money goes for that, with small and carefully thought out amounts for administration and research.

4. Yes. We support the concept of forgiving college students their loans at the rate of 25% per year if they teach math and/or science in elementary or secondary school. That is an effective device, given the high price of education. Some may not stay in teaching, but that is an acceptable risk. There will be many who remain. The point is that new, able people must be brought into teaching.

Sincerely,

RLS
Robert L. Smith
Executive Director

RLS:maw

EDS
Electronic Data Systems Corporation
6430 Rockledge Drive
Bethesda, MD 20034
(301) 897-9600

7 April 1983

Senator Robert T. Stafford
Chairman
Subcommittee on Education
   Arts and Humanities
SD-428 Dirksen Senate Office Building
Washington, D.C. 20510

ATTN: Mr. David Morse

Dear Senator Stafford:

This is in response to, your letter of 30 March 1983 with additional questions from Senators Pell and Dodd regarding my testimony before your subcommittee. My responses are as follows:

1. "Do you feel that the necessity to train entry-level personnel to compensate for inadequate math and science education is a common problem to most private sector firms?"

   I only feel competent to comment on this question as it relates to entry-level technical positions within the data processing industry. In that instance, my response is yes, I do feel it is common.

2. "In your opinion, are we dangerously behind the Japanese with respect to technological literacy?"

   Yes, we simply do not produce an adequate number of engineers and other technically skilled personnel to retain our technological leadership.

3. "What degree of sophistication in math and science will be required of our students to meet the need for skilled labor?"

   At the high school level, four years of progressive mathematics to include algebra, geometry, trigonometry, and calculus should be stressed. These courses should introduce students to numbering systems, statistics and logic. Science education should include basic electronics and an introduction to simple physics. College level courses should include a more in-depth coverage of the high school math and science curriculums. Specifically statistics, differential equations, probability, and mathematical analysis should be stressed. Engineering courses in digital electronics and advanced physics are also applicable.

Neither high school nor college curriculums should overlook the need for strong writing skills.

4. "Do you feel that the emergence of high tech firms will create many jobs which will require low skill levels - as well as jobs that will require high skill levels - of our workforce, and what degree of mathematical competency will be required to fill these new low-skill jobs?"

   That portion of this question which relates to the creation of low-skill and high-skill jobs as a result of the emergence of high tech firms has been responded to as the result of a previous question from Senator Stafford (See my reply of 24 March 1983).

   Regarding the degree of mathematical competency required to fill the new low-skill jobs I would insist that the degree of education listed for the high school level, in response to question 3 above, must be our goal. Part of my insistence for that level of competency is driven by my firm belief that those who enter the low-skill jobs would prefer to enter the high-skill jobs if their circumstances permitted. That is, if they could obtain the necessary higher education. Their only alternative, then, is to enter the low-skill jobs but hopefully, through experience or through continuing educational pursuits, to work themselves into the high-skill and higher paying positions. To do this they must have a sound basic understanding of math and science.

I would like to thank you again for the opportunity to participate in the activities of your subcommittee and to wish you every success with your bill.

Sincerely,

Gilbert D. Johnson

Gilbert D. Johnson
Manager
Training and Education

GDJ/das

National Association of State Boards of Education

April 11, 1983

Senator Robert T. Stafford
Committee on Labor and Human Resources
Washington, D.C. 20510

Dear Senator Stafford:

The following are responses to your questions.

1. Foreign Language Instruction.

The National Association of State Boards of Education strongly supports foreign language education. There is surely need for more attention to this area, for a variety of reasons. These include direct benefits to students and society, the growing importance of international economic relations and the continuing requirements of diplomacy.

Given the nature of the foreign language challenge, however, we wonder how much of a role it is reasonable to expect the federal government to play, at least at the public school level.

So far as we are aware, for example, there is no serious shortage of foreign language teachers; where shortages do exist, they appear to be scattered or limited to languages which have not been the traditional province of elementary and secondary schools. Nor, so far as we can tell, is there a serious problem with curriculum; the curriculum could of course be improved, but this had not been the major stumbling block to more foreign language learning.

The major problem has been, quite simply, the number of years students study, or are required to study, other languages. This questions is controlled entirely by state and local school systems, which must weigh it along with all other competing demands on the school day. As a rule, of course, any additions to what students are taught dictates the elimination of other subjects they have been learning in the classroom.

The chief task for Washington, then, would be somehow to convince school systems to establish and require many more foreign language classes rather than other subjects now being taught or contemplated. We cannot say how successful such an endeavor might be, and we are hesitant to suggest which languages might be stressed. That would require an extensive examination of student preferences, of the benefits to domestic relations among various groups, of the needs of multinational corporations that are not met by foreign nations, of diplomatic requirements and of numerous other factors.

2. Math and Science Funding.

We believe math and science funds must be invested at both the elementary and secondary levels. It is impossible to estimate precise balances between the two levels, but we suspect that a relatively larger investment in the high schools might be wise. This is simply because the evidence suggests that students in early grades tend, on average, to do fairly well in both subjects, and that notable fall-offs occur at the secondary level.

As for distribution formulas, common sense dictates that funds be targeted as possible on places with the greatest needs, such as those with the most severe shortages of qualified math and science teachers. Any formulas that disburses funds to areas where they are not needed is folly. We therefore urge that funds be distributed to the states, with a requirement -- and state plans approved by the Secretary -- for disbursing them according to greatest need.

3. Vocational Education.

Funds for vocational education are already provided in specific voc ed legislation, as well as in other measures. We would oppose, therefore, using the very limited funds in the math and science bill for vocational education purposes.

4. Teachers.

There well may be factors other than the largest one, money, that are drawing math and science teachers away from the classroom. These may include, for example, the reduced regard which teachers are held in our society today and other frustrations of their jobs. These are, however, beyond the reach of the federal government and, therefore, the legislation at hand.

5. Materials.

Inadequate or obsolete materials play a large role in producing technological illiteracy. However, we are finding that the need for thoroughly trained teachers is becoming an even greater obstacle. We are enclosing a copy of a recent article published by the Wall Street Journal which describes the situation faced by many school systems.

Sincerely

Robert Wolfenbarger

Robert Wolfenbarger
New Jersey State Board of Education

RW/AE/tw

Enclosure

THURSDAY, APRIL 7, 1983

THE WALL STREET JOURNAL.

Many Schools Buying Computers Find Problems With Using Them

By Burt Schorr
Staff Reporter of The Wall Street Journal

POMPANO BEACH, Fla.—Many schools are learning that there's more to teaching with computers than buying the machines.

Tedder Elementary School here last October acquired three Apple II Plus microcomputers. They were among 900 Apple IIs that the Broward County school system purchased under a $2.1 million computer-expansion program. But only a few of Tedder's 520 students and 30 teachers have even tried the new machines. Computers aren't likely to have a major role at the school anytime soon, says Tedder's principal, Robert Snyder.

One reason is a lack of instructors and instruction time for teachers. Another is that the county hasn't allocated any special funds to buy the software programs to use with the computers. Tedder owns only two computer-program disks, which Mr. Snyder bought with $60 from a small school fund; the disks are intended to instruct second- and third-graders in telling time and counting money. But Mr. Snyder says that until he decides on the disks' instructional value, only three gifted students will use them.

As schools rush to computerize U.S. classrooms, many find themselves in a similar predicament. The problems often persist even if the schools have the money to buy the programming for the computers.

Behaving the Wrong Way

Under pressure from parents and school board members to begin computer instruction, "schools are behaving in exactly the wrong way," contends Phillip Mackey, an official of the School Boards Association in New Jersey, a state where many local districts have invested heavily in computers. "First they buy the machines. Then they buy the software," Mr. Mackey says. "Then they start to think, 'Why did we get into this in the first place?' "

Inadequate planning is common. Computer-education consultants say a frequent error is failure to equip at least one classroom with a minimum of one computer for each two students, typically 12 to 15 machines.

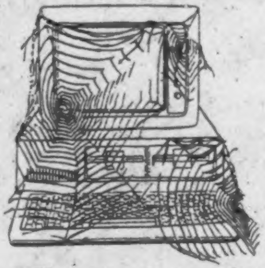
One Southwestern U.S. school district with 50,000 students recently considered a $2.5 million computer plan that would have provided its elementary and junior high schools with only a single computer apiece for "computer literacy" instruction. Noting that the plan would limit students to just two hours of computer work annually, advisers from a local university told district officials that "they'd be better off using the money to buy the kids crayons," one of the advisers recalls. The district decided to rethink its plan.

Teachers also complain about much of the software that is available for classroom computers. They contend it is too heavily oriented to mathematics and to drill and practice exercises that do little to challenge students' powers of analysis.

Gail Gallagher, head of the English department at Broward County's Coral Springs High School, says nearly all of the software she reviewed recently was "horrendous." One program that she flunked was an exercise in distinguishing between homonyms, such as "sun" and "son." The computer program failed to provide any remedies for students who repeated the same error over and over, she says.

Another flunker, she says, "flashed a great big red X" on the computer screen to signal the user's error. "That's like telling a kid, 'You dummy, you dummy.' " Mrs. Gallagher complains.

In a joint project of Education Products Information Exchange, a nonprofit organization in Watermill, N.Y., and Consumers Union, 300 teachers are evaluating classroom computer programs. Of the initial 50 programs reviewed, only a fourth got a grade of 60% or better. Many of the drill and practice programs failed, for instance, because they allow users to "guess their way through," says Kenneth Komoski, the Exchange's executive director.



"It seems to the teachers that this county is dumping vast amounts of money for equipment nobody is using," a Broward County, Fla., teacher says about computers.

Some school consultants wonder if the current enthusiasm for classroom computers will give way to the same disenchantment that has overtaken previous educational fads. But such skepticism is rare among parents, administrators and teachers.

"We in education have to recognize that we live in a computerized society," says John Bristol, superintendent of the Lyons Township high school district serving several suburban Chicago communities. The district's 3,700 high school students have access to 240 Radio Shack Model III microcomputers—one of the highest computer-student ratios in the country.

Lyons Township sees computer technology as "a subject to be taught" rather than as "a tool for teachers," Mr. Bristol asserts. All the same, the system has about 200 software programs for classroom use. One teaches music students guitar fingerings. Another teaches typing students how to use computers as word processors. A third, used in a health course, demonstrates the hazards of drinking alcoholic beverages.

More than a few students enjoy comparable computer benefits here in Broward County, where each senior high school has a minimum of 30 microcomputers and each junior high has at least 20. But under-used computers aren't hard to find, and the $2.1 million computer purchase has irritated many teachers. Teacher salaries here average $19,300 a year, and the school board recently imposed a labor contract giving teachers less money than they had hoped to get.

"It seems to the teachers that this county is dumping vast amounts of money for equipment nobody is using," contends Linda Pearson, a kindergarten teacher who serves on the board of the Broward County Classroom Teachers Association.

Despite such criticisms, the boom in classroom computers is expected to expand. At the end of last year, schools were using about 274,000 desktop machines, more than double the year-earlier total, and they will have nearly 1 million units by 1986, estimates International Data Corp., Framingham, Mass.

Free Training

Computer companies are encouraging the trend by trying to help overcome the lack of teacher training. In March, Tandy Corp. announced that it will provide public and private school teachers and administrators with up to 24 hours of free training at any of its 500 Radio Shack computer-training centers. International Business Machines Corp. says that it is giving 1,500 personal computers to 840 schools and 12 teacher-training institutions in California, New York and Florida as part of an $8 million instructional program.

More than 600 producers of home-and-classroom computer-education programs are vying for shares of what is estimated to be a $150 million market this year and a much bigger market later. These producers range from individual teachers working at home to companies such as Milliken Publishing Co., St. Louis, a leading maker of classroom programs.

Many educators say some software seems to be improving but a number of school systems are learning the hard way that some highly rated programs may not be compatible with their specific computer system.

Michelle Annette, a special-education teacher at Homestead High School in Cupertino, Calif., says she liked the Milliken Math Sequences programs she tried at a recent software fair run by her school. "They go slow enough for my kids and cover what they need" in adding, subtracting, multiplying and dividing, she says.

Unfortunately, the Milliken math series won't run on the computers at Homestead High and other schools in the local Fremont-Union High School District. The Silicon Valley school system wanted to stretch its $275,000 computer investment as far as possible. So instead of supplying program disks for each of its Apple microcomputers it tied the 15 Apples at each school into a Corvus Systems Inc. network served by a single disk. But producers of school software design their copyrighted products with electronic "locks" to prevent their use with such net-

Please Turn to Page 37, Column 3

Schools That Purchase Computers Often Have Problems Using Them

Continued From Page 31

works, and only a few programs priced for network use have reached the market.

The district was gambling that "by the time we got teachers trained," the software problem would be solved, says Michael Summerbell, Fremont-Union coordinator of computer instruction. That hasn't happened yet, though, often forcing teachers like Mrs. Annette to use courseware they consider inferior that isn't copyrighted.

Milliken Publishing has promised "a network solution" by fall, though it has misgivings about network use of its programs. Bodie Marx, vice president in charge of computer software for Milliken, notes, for example, the company's $500,000 investment in its math series. "With an investment like that, it scares us to think that hundreds of students could work from one disk," he says.

Too many school systems are buying computers that can't be integrated with classroom work or existing equipment, says Marc Tucker, a Washington, D.C., analyst of classroom computer policies. Once delivered, the computers go "into the hands of teachers who are frightened by the machines and have no sources for learning how to use them," he says. Mr. Tucker's remedy: schools should allot only 25% of their computer funds to hardware and maintenance. Another 25% should be reserved for software. The remaining 50% should go for planning, teacher training and other support services.

April 1983

To: Senator Robert T. Stafford
Chairman, Subcommittee on Education, Arts and Humanities
United States Senate
Committee on Labor and Human Resources

From Calvin M. Frazier, President
Council of Chief State School Officers
Colorado Commissioner of Education

Topic: Responses to Senate Committee Questions on Proposed Mathematics, Science, and Foreign Language Legislation

In response to your March letter asking for answers to specific questions on the proposed legislation, I would submit the following reactions:

1. Q. Are there pitfalls in a federal mathematics and science initiative? Are other areas being neglected?

   A. The only pitfalls might be as follows:
      1. Setting in motion a federal involvement that has no ending. Some involvement can be justified to achieve a specific national objective and outcome. After that end has been attained or it becomes obvious the approaches taken are not having the desired outcomes, the legislation should be terminated or modified.

         Legislative implications of the above statement

         The legislation should include a sunsetting provision, i.e. four years, suggesting to all parties the need to make the best use of these provisions in the time provided.

         It could also argue for including some reporting and evaluation provision that would advise Congress, states, and the public on the progress made and the annual status of math and science teaching and programs in America.

      2. Some provision must be made for the state to address the broader policy issues relating to recruiting, training, rewarding, and retaining teachers in these critical areas. Policy makers must look at state laws, regulations, and practices that may adversely impact these factors, plus high school graduation or college admission standards or teacher education and certification. Unless these components are examined and perhaps changed, the federal corrective actions initiated are superficial and short-lived.

   B. Q. Are other areas neglected?

      A. There are good arguments for considering a foreign language emphasis in the Senate legislation to address national security and economic development concerns.

2a. Q. Should there be an intrastate distribution formula?

A. Yes. This would eliminate 50 state arguments over these figures and expedite implementation of programs to address the problems.

2b. Q. Does Congress dilute the effort if funds go directly to school districts in each state?

A. Yes. If all monies go directly to local school districts and institutions of higher education for training teachers and/or buying equipment, the educational system is not fully impacted in terms of the various components listed in A(2) above. Some monies should be available to state level studies and changes involving state K-12 and higher educational policy makers. Other monies should flow quickly to local districts by a pre-set distribution formula.

Ideally, I believe the state/local mix should change over the life of the legislation (if 4 years, for instance). A higher percent should go initially to the state level to ensure the development of a state plan for best utilizing the future monies and preparing K-12 and higher education fund recipients to have the broadest vision possible in implementing the federal supplementary legislation. Dollars for state level or institutional policy makers could be reduced over the four year span with school districts and representatives of higher education i.e. professors or departments receiving a greater percentage of the funds.

2c. Q. How do federal funds reach the areas of greatest need?

A. Congress can either assume the problem is general and widespread or that states should be free to determine the areas of high need. I would advise Congress to assume the problem is general in nature and not require extensive legislation (or rules) or state-wide debates to slow implementation of local and state plans to make change. Settle the distribution question at the national level and assume widespread and common problems.

If some monies are provided for state level analysis and discretion, these funds can provide the targeting as a state sees appropriate. The bulk of the funds can be effective in a formula distribution.

3. Q. Is there a "rule of thumb" in determining the division of funds between teacher training, equipment or other needs?

A. With the monies being considered ($50 M to 500 M) I would see these funds going to support the development of state plans, revisions of policies relating to science, math and foreign language instruction and teacher factors. If these contributions work well in a state, tax credit plans for businesses helping to supply equipment to schools and institutions of higher education could be the stimulus to address the equipment needs.

A suggested Division of State funds:
(assuming a four year cycle)

Year One

5%	State Planning relative to maximizing the value of the federal monies.
10%	Technical Assistance and Management - State Agency.
65%	School District support.
20%	Higher education - teacher training, etc.

Years Two and Three

10%	State assistance and managment.
70%	School district support.
20%	Higher education

Year Four

5%	State agency management and evaluation support.
75%	School district funds.
20%	Higher education.

4. Q. Should a loan forgiveness provision be provided?

A. No. It would seem that the mechanics of such programs are not efficient. Secondly, I would anticipate that individuals utilizing the "forgiveness provisions" would do so as a plus not as a determinant of entering the teaching profession. Grants, scholarships, and retraining of currently unemployed teachers would appear to have a greater return.

Final Question relative to Council of Chief State School Officers (CCSSO) Position Statement:

Regarding the intrastate distribution, is there a correlation between poverty in a district and that district's deficiency in math and science education?

I am not aware of correlation figures of the nature indicated in the question. I believe the CCSSO concern would relate more to distribution of the federal monies might be most equitable if the variations in district "wealth" were considered. The fiscal strength of the district may not be related to the incidence of poverty within the district.

I will ask the CCSSO legislative liaison to talk with you about any data that may be available in relationship to the question posed.

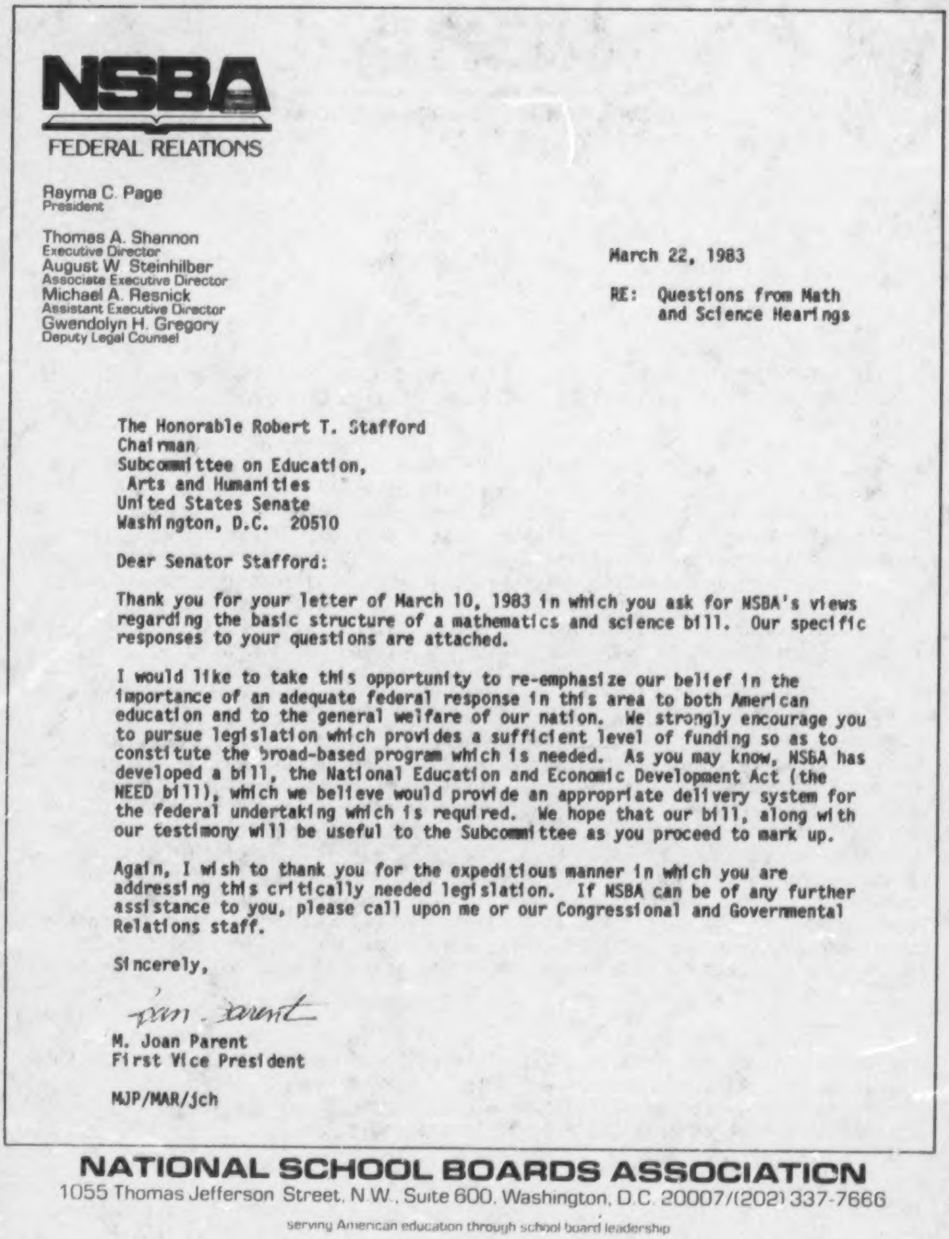
I hope these comments are helpful to your deliberations.

Sincerely,

Calvin M. Frazier

Calvin M. Frazier
President, Council of Chief State School Officers
Colorado Commissioner of Education

CMF/jg



NSBA
FEDERAL RELATIONS

Rayma C. Page
President

Thomas A. Shannon
Executive Director
August W. Steinhilber
Associate Executive Director
Michael A. Resnick
Assistant Executive Director
Gwendolyn H. Gregory
Deputy Legal Counsel

March 22, 1983

RE: Questions from Math
and Science Hearings

The Honorable Robert T. Stafford
Chairman
Subcommittee on Education,
Arts and Humanities
United States Senate
Washington, D.C. 20510

Dear Senator Stafford:

Thank you for your letter of March 10, 1983 in which you ask for NSBA's views regarding the basic structure of a mathematics and science bill. Our specific responses to your questions are attached.

I would like to take this opportunity to re-emphasize our belief in the importance of an adequate federal response in this area to both American education and to the general welfare of our nation. We strongly encourage you to pursue legislation which provides a sufficient level of funding so as to constitute the broad-based program which is needed. As you may know, NSBA has developed a bill, the National Education and Economic Development Act (the NEED bill), which we believe would provide an appropriate delivery system for the federal undertaking which is required. We hope that our bill, along with our testimony will be useful to the Subcommittee as you proceed to mark up.

Again, I wish to thank you for the expeditious manner in which you are addressing this critically needed legislation. If NSBA can be of any further assistance to you, please call upon me or our Congressional and Governmental Relations staff.

Sincerely,

Joan Parent

M. Joan Parent
First Vice President

MJP/MAR/jch

NATIONAL SCHOOL BOARDS ASSOCIATION
1055 Thomas Jefferson Street, N.W., Suite 600, Washington, D.C. 20007/(202) 337-7666

serving American education through school board leadership

NSBA
NATIONAL SCHOOL BOARDS ASSOCIATION
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NSBA RESPONSE TO SUBCOMMITTEE QUESTIONS

1. ARE THERE ANY POTENTIAL PITFALLS IN A COMPREHENSIVE FEDERAL MATHEMATICS AND SCIENCE EDUCATION INITIATIVE? ARE WE NEGLECTING OTHER NECESSARY SUBJECTS OF STUDY?

Answer. In our view, a comprehensive program is the proper direction to take in developing a mathematics and science initiative. There are two main related reasons for this position: (a) the needs, priorities, and goals of each local community vary sufficiently that a narrowly defined program (or several categorical programs) would not necessarily result in the best use of federal funds on a district-by-district basis, and (b) school systems should be encouraged to develop curriculum and programs on a comprehensive basis rather than fragmenting their efforts among various categorical components, e.g., teacher training, business relationships, equipment, etc.

The main pitfall to a comprehensive approach is whether Congress will fail to authorize an adequate level of funds to fulfill the promises of a comprehensive program. A comprehensive program in mathematics and science would cost at least $1 billion annually. In recently passing H.R. 1310, the House of Representatives recognized that $250 million could not purchase $1 billion of services. Within the framework of a limited bill, that bill will not raise false expectations because, for the most part, it is focussed primarily on capacity building (i.e., costs of resource development, such as planning and in-service training), rather than maintenance (i.e., costs of underwriting the classroom, such as salaries, laboratory equipment and textbooks). At the same time, as a capaciaty building bill, it is reasonably comprehensive in scope. The point is, even at several hundred million dollars, a bill can be made to be comprehensive -- without encountering the pitfall of "over-promising."

In our view, foreign language study is an intricable part of both upgrading science and promoting U.S. international business interests. Within the scope of what a mathematics and science initiative is seeking to accomplish vis-a-vis the national interest, foreign language study fits into the bill -- provided adequate funding is available.

2(a). SHOULD THERE BE ANY INTRASTATE DISTRIBUTION FORMULA IN A LEGISLATIVE INITIATIVE TO DEAL WITH THE MATH AND SCIENCE EDUCATION PROBLEM?

Answer. It is absolutely crucial that the overwhelming bulk of funds be distributed to local school districts pursuant to a federally determined student count formula. Experience has demonstrated that federal programs are best integrated within the ongoing operation of the school district if there is a level of certainty built into the funding process. Local formula funding encourages that certainty, whereas a state discretionary distribution moves in the opposite direction and rewards districts for their financial and political wherewithall to pursue project grants. While project grants can serve a valuable innovative purpose as a component of a larger program, they should not be the main component of a bill -- particularly a bill of significant size. Further, in adopting an intrastate formula, that formula should be federally established rather than a formula determination by the states regarding such factors as minimum size or permissive formula adjustments. In practice, a state developed formula opens the program to grantsmanship, political considerations, and ultimately can mean no formula at all. Where federal funding is severely limited or special needs exist, a federal formula can be developed to deal with that problem -- without resorting to discretionary grants as the main funding vehicle.

2(b). IF WE ARE SPEAKING OF A MAXIMUM LEVEL OF FUNDING OF NO MORE THAN $500 MILLION, DO WE SERIOUSLY DILUTE OUR EFFORT IF WE REQUIRE FUNDS TO BE PASSED THROUGH TO ALL SCHOOL DISTRICTS WITHIN A STATE?

Answer. Whether $500 million is too small an amount for all districts to share on a meaningful local formula basis depends upon what the program is geared to do. If the primary purpose of the bill is capacity building, then a local formula distribution would not dilute the federal effort. Our small rural school systems can make good use of $1,000 for in-service training just as our large school systems can utilize several hundred thousand dollars of funding for the same purpose. If the entire $500 million is targeted to elementary and secondary education, the dollar level is adequate for the program to be in the nature of a full comprehensive bill (i.e., capacity building and maintenance). However, at that level, the federal formula might be designed to target funds or to create a higher priority for districts with special needs.

2(c). IN LIGHT OF SEVERAL STUDIES INDICATING THAT STATE DISTRIBUTION OF CHAPTER II BLOCK GRANTS MORE CLOSELY MIRRORS GENERAL ENROLLMENT PATTERNS IN STATES RATHER THAN PATTERNS OF GREATEST NEED, WHAT ASSURANCE IS THERE THAT STATES WILL DISTRIBUTE FEDERAL MATH AND SCIENCE FUNDS TO AREAS OF GREATEST NEED?

Answer. If Congress wishes to distribute funds to school district with particular needs, a locally based federal formula should be developed for that purpose.

3. SHOULD THERE BE ANY "RULE OF THUMB" WE SHOULD FOLLOW IN DETERMINING THE PROPORTIONS OF FUNDS TO BE EXPENDED ON TEACHER TRAINING, FOR EXAMPLE, AS OPPOSED TO INSTRUCTIONAL EQUIPMENT?

Answer. A "rule of thumb" cannot be established for determining what portion of funds should be spent on teacher training, equipment, or any other purpose. The reason is that the needs of each school district vary. However, school boards can be asked to establish priorities. If federal funding is limited, teacher training and other capacity building activities should be funded first, leaving the higher cost maintenance costs to be funded once capacity building is complete. (From a practical standpoint, capacity building and maintenance costs should be supported simultaneously.)

4. I ASKED THE PREVIOUS PANEL ABOUT THE QUESTION OF LOAN FORGIVENESS. DO YOU BELIEVE LOAN FORGIVENESS WOULD BE AN EFFECTIVE MECHANISM TO HELP IMPROVE THE QUALITY AND INCREASE THE QUANTITY OF MATHEMATICS AND SCIENCE TEACHERS?

Answer. A loan forgiveness program may be a useful component of a larger program. However, it should be emphasized that the first personnel priority need is to upgrade the content knowledge and instructional skills of the existing teaching force -- both elementary and secondary. With respect to new teachers, loan forgiveness can work within certain limits. For example, we do not believe that they will attract the best students, nor will they necessarily result in teachers remaining in the profession beyond the term of their loan forgiveness.

5. ONE OF THE ARGUMENTS FOR A FEDERAL ROLE IN MATHEMATICS AND SCIENCE EDUCATION IS THE CRISIS WE FACE IN PROVIDING AMERICANS WITH THE TECHNOLOGICAL SKILLS NECESSARY TO MEET OUR ECONOMIC AND DEFENSE NEEDS. IN THIS LIGHT, DO YOU FEEL IT IS APPROPRIATE FOR THE FEDERAL GOVERNMENT TO PROVIDE GENERAL EDUCATIONAL AID FOR MATH AND SCIENCE, WHEN MOST EXISTING FEDERAL PROGRAMS PROVIDE AID TO SPECIAL POPULATIONS?

Answer. At least for the large funding programs, the federal role in education has been supported as a means for achieving some other national purpose. In recent years, the national purposes sought have been in the related areas of civil rights, poverty, and other targeted purposes, the costs of which have been beyond the means of local school systems (i.e, P.L. 94-142 and Bilingual Education Act). However, programs have been enacted in the past to serve general student participation in program areas tied to the economy and national defense, e.g., the Morrill Act, the Vocational Education Act and NDEA. The point is, from the standpoint of history as well as contemporary needs, there is a legitimate role for the federal government to finance the needs of local school districts in mathematics and science -- particularly if the fulfillment of those needs is tied to the national interest in other areas of federal concern. However, any time the federal government moves into the area of curriculum or instructional methods, care must be taken to ensure that (a) the federal government does not engage substantively in those areas, or (b) the federal government does not rearrange the local/state relationship to the extent that the state level, under its own policies, laws, and traditions, becomes more or less involved in curriculum, instructional skills, etc.

RESPONSE TO QUESTIONS FOR PANEL II

by

Susan B. Adler
Director, Washington Office
Education Commission of the States

March 22, 1983

QUESTION #1: Are there any potential pitfalls in a comprehensive federal mathematics and science education initiative? Are we neglecting other necessary subjects of study?

ANSWER: Part of the answer lies in how such a federal initiative is defined and who will be involved in shaping the definition; the remaining part of the answer lies in how comprehensive and flexible will be various approaches for carrying forward this initiative and again, who will be involved in its implementation.

The ECS Task Force on Education for Economic Growth is focusing its attention on the kinds of skills, attitudes, and behaviors needed by high school students in order to become productive and contribute to the needs of a modern technological society, and on the kind of learning environment needed which will motivate students to acquire these skills. The adequacy of these students' preparation relates back to the quality of the education work force generally, which in turn raises questions regarding the value we place on attracting, training, and rewarding the very best teachers. And, this situation relates directly to concerns over our ability to compete in the economic arena.

Our Task Force focus is broader than mathematics and science; we are highlighting skills that encompass the ability to think through problems, to reason, to analyze, and to infer and draw conclusions. What is important is that in reaching consensus on our definition, state and local policymakers, education leaders, business and industry representatives were directly involved in discussing the dimensions of the problem and in shaping approaches in which each sector could recognize their respective responsibilities in affecting change. The pitfall federal legislation must avoid is the omission of any of the essential players in defining a comprehensive federal mathematics and science initiative. With limited federal dollars to invest and with incomplete knowledge of what programs will guarantee success, we do not have the luxury to allocate money which might not reach down to the core of the problem, as experienced by individual states and local communities. Governors, legislators, chief state school officers, state and local school board members, teachers, parents, and private industry representatives must all become involved both in shaping this definition and in defining the solutions.

QUESTION #2A: Should there by any intrastate distribution formula in a legislative initiative to deal with the math and science education problem?

ANSWER: No. The history of intrastate distribution formulas, despite the most carefully constructed weighting systems and percentage distributions, essentially wash out to funding distributions based primarily on per pupil enrollment. Based on what our Task Force has seen happening in state after state and highlighted in the attached set of regional profiles, the federal government should:

(1) Define a set of criteria or purposes that must be addressed through a statewide plan, task force, or special committee. This plan must demonstrate how the elements of the problem will be addressed, how all the appropriate sectors will be involved, and outline their general roles and responsibilities for carrying forward various approaches. (These approaches could include state design of a targetted formula based on documentation of need from the locals as one way of meeting the federal criteria.)

(2) Require, within the time frame of this legislation, an evaluation by the state of the changes resulting from the impact of these federal dollars. It is important that this evaluation tie back directly to the set of criteria embodied in the state plan, and that such a report include explanations of any problems which may have been encountered, as well as any successes.

We have heard over and over again from our Task Force members that it is equally as important to understand what has not worked and why, rather than learning only about model programs. In this way, a foundation can be laid for determining what has been accomplished over the time period of this initiative, and information will have been obtained which can establish some basis for determining what future federal role may be needed.

QUESTION #2B: If we are speaking of a maximum level of funding of no more than $500 million, do we seriously dilute our effort if we require funds to be passed through to all school districts within a state?

ANSWER: Yes. Passing funds through to every local school district would seriously dilute any federal initiative in the $500 million range. This approach does not take into account the unevenness of the problem among districts, or the importance of encouraging such approaches as: (1) the formation of multidistrict consortia arrangements; (2) regional strategies administered through intermediate education units; (3) cooperative arrangements among elementary, secondary and higher education, libraries, museums and other community resources; and (4) partnerships with private industry. Again, incentives for these kinds of cooperative approaches which build on a collective sense of responsibility among state, local and private industry leaders need to be addressed through the development of individual state plans. As stated in question #1, these plans must include direct involvement of state leaders in the position to tie education resources directly to the economic development needs of their states--governors, together with legislators, chief state school officers and private industry partners. State and local education agencies alone are not able to draw these pieces together.

QUESTION #2C: In light of several studies indicating that state distribution of Chapter II Block Grants more closely mirrors general enrollment patterns in states rather than patterns of greatest need, what assurance is there that states will distribute federal math and science funds to areas of greatest need?

ANSWER: No assurance, especially if federal dollars are distributed on a formula basis to locals. Part of the difficulty lies in constructing a federal definition for "greatest need." Is teacher quality the issue of equal concern in every state? Whose definition of equity is the most appropriate? Are mathematics and science shortages of the same severity in every area? How much of the problem is student motivation and, if so, how can more of these students be drawn to participate in upper level mathematics and science courses? Many states are already in the process of gathering the data to make more precise determinations of their actual needs, as our Task Force is documenting. Federal dollars would be best leveraged within this context.

QUESTION #3: Should there be any "rule of thumb" we should follow in determining the proportions of funds to be expended on teacher training, for example, as opposed to instructional equipment?

ANSWER: No "rule of thumb" can be applied. Again, the unevenness of the problem across states and local districts makes federal proportioning difficult, combined with the uncertainty of continued federal resources. The history of Title I funding apparently demonstrated that in the early years, when schools were unsure of long-term future funding, more money was spent on "equipment."

Again, if a state develops a comprehensive plan, multiple funding sources could be addressed through this plan, with possible arrangements in certain states for equipment donations from private industries. There seems to be a general consensus that funding should be limited in the instructional equipment area, and that perhaps, a percentage limitation should be placed on the amount of dollars spent for hardware.

QUESTION #4: I asked the previous panel about the question of loan forgiveness. Do you believe loan forgiveness would be an effective mechanism to help improve the quality and increase the quantity of mathematics and science teachers?

ANSWER: Loan forgiveness does not address the underlying problem of what needs to be changed to create an environment with the growth and reward structures necessary to attract and keep the best teachers. Loan forgiveness only lowers the price tag; this strategy does not address the question of what long-term career incentives are available to encourage the best students to become and remain teachers.

NEW ENGLAND BOARD OF HIGHER EDUCATION

Commission on Higher Education and the Economy

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FOCUS:

In 1979, the New England Board of Higher Education (NEBHE) formed a special Commission composed of 31 leaders in business, education and government to explore the relationship between higher education and the economy in the six-state region. The first phase of the Commission's work was completed in March 1982 with the publication of a report entitled, A Threat to Excellence, which was disseminated to each of the region's governors, selected legislative leaders, college and university presidents, corporate presidents and the general public. The report identified three major problems confronting higher education and the economy:

- a fundamental weakening of the public school system;
- erosion of the commitment to finance higher education; and
- a negative change in the perception of New England as a region of economic opportunity.

The Commission concluded that the central task facing NEBHE is developing a more complete understanding among New Englanders of the strong influence of the quality of the region's educational system on the performance of the region's economy. Recommendations for addressing each of the three problem areas identified are designed for the purpose of regaining the competitive strength of the "knowledge intensive" New England region. In the area of particular interest to the Hunt Task Force--concern over weakening of the public school system--recommendations include: carrying out an assessment of teacher certification procedures in each of the six states, including a review of legislative constraints which may not allow flexibility for the employment of qualified teachers in such areas as science and mathematics; suggesting that senior personnel officers in the major New England corporations assist high school staff in developing curriculum relating to business and industry; and suggesting that partnerships between single high schools and individual corporations be systematically established in all states.

NEBHE's action plan focuses on highlighting projects in each New England state which carry out recommendations advanced in the Commission report. A scoreboard of progress by state will be published and widely disseminated in the Spring of 1983. An ad hoc committee is also planned, composed of members from each of the six state legislatures, including members of the finance, education, and appropriation committees. Work of the committee will concentrate on assessing the conditions in each New England state regarding the recommendations presented in A Threat to Excellence. A central goal of these state reviews is to identify the level of progress and the ways in which the public and business sectors can facilitate the contributions of educational institutions to economic development in the region.

* * * * * *

NEBHE membership encompasses the following six states: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont.

rev. 2/24/83

SOUTHERN REGIONAL EDUCATION BOARD

Task Force on Higher Education in the Schools

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FOCUS:

Coordination between higher education and public education to strengthen the quality of education at all levels in the South remains the thrust of the Southern Regional Education Board (SREB) effort. Under the leadership of former Task Force chairman and newly elected Florida Congressman, Buddy McKay, the Task Force conducted six months of meetings from January to June of 1981 among southern state policymakers, business and education leaders. From these meetings, 25 recommendations focusing on proposals for joint action by these leaders were embodied in what has become a key resource document, "The Need for Quality Report," published in June 1981. Recommendations range from proposals to strengthen college higher education admission standards, to approaches for relieving the mathematics and science teacher shortage, to suggestions for reciprocal agreements between states in such areas as teacher testing and certification.

SREB has been involved in a continual effort since the publication of the report to work with the southern states to document what each has done in relationship to these 25 recommendations. A final report, scheduled for publication in April 1983, will summarize specific actions SREB states have taken in these recommended areas and highlight those areas in which the Task Force believes further attention should be placed. SREB has recently published two information flyers, one focusing on the issue of variable pay and other rewards for teachers, and the second, highlighting activities underway in the region on raising requirements for high school graduation and college admission. A new publication entitled, "Preparation Programs and Certification Standards for Science and Mathematics Teachers," in the SREB states will be available in early March 1983. Work encompasses an analysis of certification requirements for mathematics and science in each southern state, the shortages faced by the state in these subject areas, and an outline of some of the approaches states in the region are taking to deal with the problem.

* * * * * *

The following states are included in the SREB membership: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, North Carolina, South Carolina, Tennessee, Texas, Virginia and West Virginia.

rev. 2/24/83

WESTERN INTERSTATE COMMISSION ON HIGHER EDUCATION

Western Technical Manpower Council

Co-Chairmen: The Honorable Victor G. Atiyeh, Governor of Oregon
John Young, President and CEO, Hewlett-Packard

Principal Staff: Phillip Sirotkin, Executive Director
Holly Zanville, Director of Economic Development
P.O. Drawer P, Boulder, Colorado 80302 (303) 497-0232

FOCUS:

The Western Interstate Commission on Higher Education (WICHE) is involved in an extensive two-year regional effort involving governors, state legislative leaders, presidents and chancellors of major universities and industrial and business leaders across the west to focus in on the education and manpower for the high technology industries critical to the western states in the 1980's. Funded by six separate foundations and corporations, the Council met for the first time in June 1982. Work encompasses four basic thrusts:

- State Profiles. Data collected in the Spring of 1982 and currently being updated, provides a snapshot of the supply and demand picture for high technology manpower in each western state. Information includes general statistics on the state's economy, the number of students enrolled in these courses and examples of state higher education and industry initiatives in high technology. Staff has already completed completed a document providing an overview of national and regional issues in high-technology manpower.

- Strategies for Action Report. This report catalogs 34 strategies divided into 9 chapter headings, one of which focuses on elementary and secondary education. Recommendations focus on leadership responsibilities for the following sectors: elementary/secondary, postsecondary, regional professionals, industry, state and federal government. Examples of where in the nation and the West these strategies are underway is also included.

- State Meetings. Plans are to conduct state meetings in conjunction with the legislative sessions in each western state between January and June of 1983 with a goal of each state developing its own plan in the high-technology area. It is expected that 150 state policymakers, industry and university leaders will participate. The updated state profiles, the Strategies for Action report and a regional high-technology fact book will be used as the basis for identifying what state actions should be taken for determining who should be responsible for implementation.

- Interstate Activities. Plans are underway to initiate interstate projects that address high-technology manpower issues of high priority to states in the region.

* * * * * *

WICHE is a nonprofit regional organization designed to help its 13 member states to work together to provide high-quality, cost-effective programs to meet the education and manpower needs of the West. Member states are: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington and Wyoming.

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NewYork Times 3/20/83

South Pressing for Wide Changes To Upgrade Education Standards

By REGINALD STUART

Special to The New York Times

MIAMI, March 19 — Sweeping changes in education policy are being pursued throughout the South by a growing number of political leaders who assert that the ability of their states to attract growth industries hinges increasingly on the educational depth of the work force.

This year voters in Mississippi, the nation's poorest state, approved substantive changes in the State Constitution. The vote cleared the way for legislative action making it mandatory that children attend school, establishing a state kindergarten program and raising teachers' pay 10 percent. The changes will require Mississippi to raise more than $100 million in tax revenue.

Florida, the South's fastest-growing state, is expected to adopt its first set of minimum requirements for graduation from high school, a part of several plans being pursued by leading state lawmakers and Gov. Bob Graham. Alabama and Kentucky have began an innovative low-interest program of financial aid for college students under which part of a loan would be forgiven if the student became a teacher in a public school. In Texas and Virginia, teachers of mathematics and science are paid bonuses.

Graduation Requirements

The Atlanta-based Southern Regional Education Board says that nine of its 14 member states are increasing or considering increasing their high school graduation requirements, requiring more credits in such basic studies as mathematics, science, history and English and reducing the number of electives students can choose, like art, drama and speech.

Also, nearly a third of the member states have raised their college admission standards in the past year. Half the states in the region are considering adopting the low-interest loan program that provides for partial forgiveness of the debt in exchange for service.

"I doubt that there is another region in the nation that is pursuing quality improvement in education as is the South," said Mark D. Musick, the state services officer of the Southern Regional Education Board. "For better or worse, we're getting people who are tending to take action rather than study things to death."

Interstate Board Dates to 1949

The education board, founded in 1949 as as interstate compact of Southern states and states bordering the South, completed a special report in 1981, "The Need for Quality," that has been a blueprint for some changes emerging today.

Bob E. Childers, executive director of the Southern Association of Colleges and Schools, also based in Atlanta, says he sees emphasis extending beyond attendance to encompass student performance.

Officials of both organizations said the initiative for change appeared to be coming from governors and legislators. In the past, the officials said, such impetus was almost exclusively from school boards, school systems' administrators or college officials.

Gov. Winter Led Campaign

The changes in Mississippi were championed by Gov. William Winter and his wife, Elise. They spent most of last year stumping the state for the constitutional changes that were approved by the voters last November. Gov. James B. Hunt Jr. is given considerable credit in North Carolina for leading the move for education reforms in his state.

Gov. Lamar Alexander of Tennessee and Governor Graham of Florida are now traveling their states in behalf of ambitious education proposals they have put forth in recent weeks. Governor Alexander's four-year plan would require $1 billion in additional revenues, which would be raised through a penny increase in the state sales tax, a premium tax on insurance companies and a video arcade tax.

Governor Graham's $1.5 billion, two-year package would require a property tax increase of $1 on each $1,000 of assessed property value. That is one revenue-raising proposal offered to finance the package. Leaders of Legislature have said education will get priority in their forthcoming session.

Echoing several Southern governors, Governor Graham said, "In order for us to be competitive, we have to be able to guarantee businesses and their employees' children that they will be able to attend a public school that is competitive with the best in America."

Seeking Higher Teacher Pay

In Texas, where plunging revenue is forcing cutbacks in state spending, Gov. Mark White is pushing lawmakers to approve a 24 percent pay increase for teachers over the next two years. The Legislature is calling for an increase of at least 18 percent. The Governor and legislators say better pay is essential to attract top college graduates to the teaching profession and keep good teachers in it.

Noting the recent wave of education reforms in the South, Russell Vlaanderen, coordinator of information clearinghouse services for the Denver-based Education Commission of the States, said: "The South has at least said that in order to compete economically they are going to have to beef up their education systems. I think that as a region they are trying to move forward."

He noted that several years ago the Southern states began what became a national movement to improve teachers' competency by developing knowledge and skills tests for teachers as a prerequisite for a teaching certificate.

The South had historically lagged in educational support and student achievement, although dramatic gains were made in the past 30 years, according to numerous studies on Southern education.

A study of Federal Census data by the Southern Growth Policies Board, an interstate compact of governors of 12 Deep South states, showed that from 1970 to 1980 the percentage of high school graduates in the board's member states rose by 35.5 percent, to 59.2 percent of all people 25 years old and older. The figure for the nation was 66.3 percent, and 68.6 percent for states outside the South, that study reported.

The policies board also found that expenditures per pupil in public elementary and secondary schools in its member states rose to $1,546 a year in 1980 from $802 in 1970 but continued to lag behind the national figures of $2,021 in 1980 as against $816 in 1970. The level of spending for non-Southern states was $2,124 in 1980 and $827 in 1970.

There is concern that the gaps between the South and the rest of the country could remain wide. "Although some of the rich states are getting poor, Southern states are poor states, with poor tax bases, and they can't spend as much per kid," said Mr. Vlaanderen of the Education Commission of the States.

Washington Post
3/29/83

Denis P. Doyle

Playing Politics With Math and Science

As Congress was busily marking up a major math-science bill, 40 of the nation's brightest and most energetic high school seniors were assembled at the other end of town to be honored as finalists in the 42nd annual Westinghouse Science Talent Search.

An incongruous pair of events: the students, proud, happy and distinguished; Congress earnestly logrolling, giving this to that interest group and that to this interest group as it proposes to spend more than a quarter of a billion dollars to "improve math and science instruction in the U.S." Distributed as Congress envisions it, it will be more of the same, some teacher training and summer institutes. It is a plan to distribute federal money an inch deep and a mile wide: $300 million is about $6 per school-age child.

> *"Half-baked science and math classes do more harm than good; it is better not to offer them at all."*

Spending money this way is certainly supported by ample precedent: keep the interest groups happy by giving a little to everyone. But it makes no sense as a math-science program. It will not improve teaching or learning to any appreciable degree.

What will improve math-science instruction was amply demonstrated at the Westinghouse Awards ceremony: a genuine commitment to excellence, high intelligence, very hard work, and a reward structure that recognizes these things. In fact, to discover how one improves math and science teaching and learning, simply look to those who do it well already. The Westinghouse award winners, a remarkable group of students, reveal a good deal.

Of the 40 finalists, 10 were awarded substantial scholarships. Of these 10, eight were from New York; four were Asian American, one black, one Hispanic, four white; five were young men, five young women.

The grand prize winner, Paul Ning, is a 16-year-old Taiwan-born student at the Bronx High School of Science. His comments speak volumes: "I'd finish my homework in half an hour and then go into this. I often worked into the wee hours." Among the Westinghouse "alumni," five have won Nobel prizes. The secret of their success is not just innate brilliance, though that was amply represented; it was discipline, hard work, and access to real mathematicians and scientists. The chairman of the judging panel, Dr. David Axelrod, says that "many of these students have sought contact with scientists, who have given of their time."

These students—and the remaining 30 who did not win major prizes—are the product of schools and families that care about math and science; and their teachers know their subjects and know how to teach. Even more important, the 40 in Washington were just the visible ones: more than 13,000 students entered the competition. What does this mean for the nation as it worries about the math-science "crisis"?

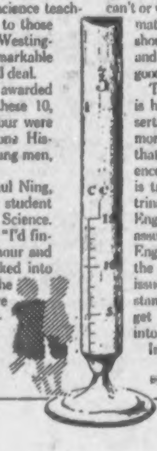
The single most important thing that could be done to improve science and math instruction is a simple, direct and easily understood structural change: impose the discipline of the market on teachers' salaries. Increase the pay of good math and science teachers. The issue is not just more money, it is how that money is spent.

Three elements are involved. First, rational criteria for math and science teacher licensing must be established. For example, teachers of high school mathematics should hold a bachelor's degree in mathematics from an acceptable institution or pass a stiff examination; they do not need a raft of education courses. On the contrary, they should be spared education courses, just as university math and science teachers are.

Second, offer science and math courses only if qualified teachers are in the classroom (internists don't do the work of surgeons; equally, there is no rational reason to reassign kindergarten teachers to calculus courses unless they can pass a math examination).

Third, pay the salary required to attract qualified teachers. And if the school district can't or won't pay the going wage for mathematicians and scientists, no courses should be offered. Half-baked science and math classes do more harm than good; it is better not to offer them at all.

The National Education Association is horrified by salary differentials, asserting that math and science are no more important than anything else, that all teachers of equivalent experience should be paid the same. Now, it is true that math and science are intrinsically no more important than English literature or Latin. Most of us assume that in the eyes of God, an English teacher is the moral equal of the math teacher. But that is not the issue: the question is how to raise standards, improve performance and get math and science teachers back into the classroom.



by [illegible]

In a society that believes in division of labor and compensation for performance, there is no mystery. It is important to remember that there is no shortage of mathematicians and scientists: the "teacher shortage" is the problem. There is no teacher shortage either, simply a serious imbalance in supply and demand.

The "equality of all teachers" solution offered by the NEA condemns us to the continuing equality of mediocrity. If the recent congressional pay raise is any example, one might assume that Congress believes you get what you pay for. But unfortunately, the modern Congress is not likely to endorse higher pay for qualified math and science teachers because of the political muscle of the NEA.

The spectacle of congressional activity in this area is enough to make one long for the good old days, when logrolling was a class act and not a matter of scattering crumbs to special interest groups. Once upon a time powerful committee chairmen kept the rewards for themselves and their constituents. (Remember Mendel Rivers and the amount spent for military installations in his district? When you get right down to it, it makes as much sense as any other way to distribute the largess.)

In the case of science and mathematics, we might all be better off if Carl Perkins would simply target most of the funds for his congressional district. A few hundred million dollars for math and science in eastern Kentucky has a certain appeal to it; and it could make quite an impact. With that kind of money, Perkins and the various school officials of his district could afford to hire 50 or 100 of the past Westinghouse science winners at competitive salaries and turn part of Appalachia into a math-science lighthouse for the nation.

It couldn't happen to a more deserving part of the country, and paying good teachers what they deserve has a better chance of success than do the bills before Congress.

The writer is director of education policy studies at the American Enterprise Institute.

Senator **Pell**. I apologize on behalf of the committee for the hastiness with which this hearing may seem to be accompanied, but we are under some pressures here. For example, I was down here on the Hill for a church breakfast. I spent an hour and a quarter with the President at the White House on San Salvador. We then floor-managed a bill on the floor. There is an executive meeting of another committee going on and we have had this hearing going on.

So, you can see we are not doing our job very efficiently, but we are doing it the best we can. We will submit some questions to you in writing. The record will be kept open for a month, at least. I would like to stay and ask them myself now, but I am a host to a luncheon that started 20 minutes ago to nine people from my State. I hope that none of you will have to operate under those pressures.

I wish you well, and the hearing is recessed until 10 a.m. tomorrow.

[Whereupon, at 12:34 p.m., the subcommittee was adjourned.]

EDUCATION FOR ECONOMIC SECURITY ACT

WEDNESDAY, MARCH 9, 1983

U.S. SENATE,
SUBCOMMITTEE ON EDUCATION, ARTS AND HUMANITIES,
COMMITTEE ON LABOR AND HUMAN RESOURCES,
Washington, D.C.

The subcommittee met, pursuant to adjournment, at 10:05 a.m., in room SD-430, Dirksen Senate Office Building, Senator Robert T. Stafford (chairman of the subcommittee) presiding.

Present: Senators Stafford, Hatch, Denton, Pell, and Kennedy.

Senator STAFFORD. The Subcommittee on Education, Arts and Humanities will please come to order.

On behalf of the subcommittee, Senator Pell and I recognize all of our guests and the witnesses who will help us today. I am pleased to convene this second day of hearings on legislative initiatives to deal with the critical problems of mathematics, science, and foreign language education in our schools.

Yesterday we heard from Senators, from science and mathematics teachers, industry representatives, and representatives of the State education agencies and school districts regarding what they believe to be the best approaches to these problems.

We learned again what we already suspected, that the problems of teaching and learning in mathematics and science are many and complex and require a comprehensive approach at the Federal level.

Today we will hear from the administration, from representatives of the teaching profession, from representatives of the higher education community, and again from industry on these matters. Through these hearings, we hope to fashion a response which will in the immediate future and for the long term get us back on the track of economic strength so necessary for a secure future.

Senator Pell, do you have an opening statement?

Senator PELL. I do. Thank you, Mr. Chairman. As I mentioned yesterday, I was very, very heartened when the President in his last state of the Union address called for, "a quality education initiative to encourage a substantial upgrading of math and science instruction through bloc grants to the States."

While we may disagree with the approach that initiative might utilize and while I believe the problem demands more time than just the upgrading of instruction, I applaud the administration for recognizing the existence of a very real problem in this area.

Its willingness to advocate a new education initiative in this period of economic austerity is to be commended. I look forward to the Secretary's testimony and in working with the administration in fashioning a viable program upon which I hope we can all concur.

And I would add how lucky we are in the educational community to have Secretary Bell in that job because I think that he has done the best possible job that can be done for education and deserves far more credit than he has received. And I just wanted to pay my credit to his contribution to the educational needs of our Nation at this time.

In addition, I am very glad to know we will hear today from the presidents of the two major teacher organizations in our Nation, the AFT and the NEA. Their input is most necessary if we are to develop a Federal program that enhances instruction in the classrooms of America because that is really where success of any math and science and computer technology act will ultimately be determined.

And finally, we will hear this morning about another aspect of the economic security problem that is most often neglected; by that I mean the need to upgrade the quality and quantity of foreign language instruction in our schools, a field where we have failed miserably in the past.

I look forward with much interest to what our witnesses will say.

Senator **STAFFORD**. Thank you very much, Senator Pell. It is always a pleasure to work with you on these matters, and in a minute I will express my own pleasure at having Secretary Bell here, but in the meantime, the chairman of the full committee, Senator Hatch is present, and I would welcome any opening statement that you have, Senator.

OPENING STATEMENT OF SENATOR HATCH

Senator **HATCH**. Well, thank you, Mr. Chairman. I am certainly happy to be here and welcome you, Mr. Secretary, before this subcommittee, and to be here with my two colleagues who do an excellent job in this area, of course, the chairman of this committee, Senator Stafford, and the ranking minority member, Senator Pell, both of whom have their imprint all over the education laws of this country. I want to join with the chairman in welcoming you here today, and as you may already know, yesterday in the Senate I introduced Senate bill 706, the science and mathematics bill developed by the administration. I do want to insure that it will receive proper and adequate consideration in the deliberations of this subcommittee, as we set about blending the best of all the proposals to come before the Congress into the type of a science and mathematics eduational package that will help our State and local school systems to improve the quality as well as the quantity of the important offerings in this field.

Mr. Chairman, I would ask that the balance of my remarks be placed in the record at this point.

Senator **STAFFORD**. Without objection, it will be.

[Continuation of Senator Hatch's opening statement follows:]

OPENING STATEMENT OF SENATOR HATCH—Continued

Senator **HATCH**. Mr. Secretary, I want to join with the chairman of the subcommittee, Senator Stafford, in welcoming you here this morning. As you may already know, yesterday in the Senate I introduced Senate bill 706, the science and mathematics bill developed by the administration. I want to insure that it will receive proper consideration in the deliberations of this subcommittee as we set about blending the best of all of the proposals to come before the Congress into the type of a science and mathematics educational package that will help our State and local school systems improve the quality, as well as the quantity of their offerings in these important fields.

Yesterday, before the subcommittee, Senators Domenici, Hart, and Chiles described the crisis our country faces because of the declining quality and quantity of the course offerings in science and mathematics available to the youngsters in our schools. Other witnesses supplied frightening data to verify not only the decline in the number of teachers who are qualified to teach science and mathematics, but the concomitant inability of school systems to offer sophisticated course content because of the shortage of competent teachers in these advanced areas of instruction.

In introducing S. 706 yesterday, I said that it was an initial step in the direction of helping resolve the situation on a short-term basis. As a former high school chemistry teacher yourself, I am sure you are abundantly aware that well-designed science and mathematics programs can introduce students to challenging experiences in these fields long before the ninth grade in high school where S. 706 begins to take effect. The early exposure of students in the middle school or elementary school years is essential to a well-integrated program that will engender an interest in students in pursuing more difficult courses in their later secondary school experiences. They also need qualified teachers.

Students in other nations with which we must compete for parity in the world technical marketplace often have several years of experience in science and mathematics before reaching the high school level. Well-qualified imaginative teachers in these early years of instruction are essential if youngsters are to develop the fundamental skills required for the work of the secondary school. For this reason, I would hope that out subcommittee will carefully examine each piece of legislation before us and that we will take the best of each and come up with creative legislation which will help State and local school officials develop an instructional program and staff adequate to the task our schools face.

Somewhere along the line we seem to have lost track of the fact that only about 1 percent of the population of the United States is trained as engineers and scientists. Yet, most of the science and mathematics education effort in our country has been under the misguided influence of the academic research community, which as someone has suggested, does not really have a philosophical rationale for or against science education for the nonscientist. Most, it seems, simple do not think about it or care.

It is my hope, Mr. Secretary, that we can fashion legislation that will take a practical, pragmatic approach in helping State and local school officials in their efforts to correct the science and mathematics shortfalls in their schools. Moreover, we all need to assist the nonscientist public in becoming more science and mathematics conscious, so that the youngsters of those who pay for, benefit from, or suffer the ill effects of what we do will be encouraged to develop excellence in the fields of science and mathematics equal to or better than their counterparts in other countries.

I will have some questions for you, Mr. Secretary, which I will submit in writing. I look forward to your testimony.

And as soon as you are through with your opening remarks, Mr. Chairman, could I ask for just a 2-minute recess so I can chat with the Secretary back here just for a second. I know that is unusual, but I would appreciate it if you would let me do it.

Senator **STAFFORD**. Under the circumstances, the Chair thinks it is justified, and the committee will stand in recess, briefly, to give you an opportunity to confer with the Secretary before he testifies.

Senator **HATCH**. Thank you so much.

Senator **STAFFORD**. We will include in the record at this point an opening statement by Senator Kennedy, who will be joining the hearing shortly.

[The opening statement of Senator Kennedy follows:]

OPENING STATEMENT OF SENATOR KENNEDY

Senator **KENNEDY**. Let me first commend my two colleagues, Senator Stafford and Senator Pell, for their wisdom in calling this series of hearings. I would also like to welcome our distinguished witnesses.

I don't think that you or many other people in this room today are unaware of the magnitude of the problem that our public education system faces, particularly in the area of mathematics and science. Our public school system must deal with a new era of technological sophistication with undertrained teachers, inadequate staff, out-of-date courses, and poor equipment. They cannot teach our next generation with these inadequate tools.

Today we continue a process which I am confident will culminate in a program to provide our school system with the tools that it needs. I have spoken many times over the last few months about the need for a program to restore excellence to our public schools. Within the next week, I intend to introduce the first piece of that program—The National Education for Economic Development Act.

I will not dwell on the details of my bill or on the problems it addresses. My colleagues and other witnesses have painted a picture of inadequacy that I cannot add to. I would, however, like to make two brief points.

First, our efforts must not be narrowly focused on a small population of elite students. Rather, it must encompass the wider population, while encouraging all students to receive training in math and science. Second, we must not focus exclusively on the secondary schools or the colleges. In the long run, the greatest benefits could arise from new efforts at the elementary school level. Our program should look to helping students at all levels. Both points are embodied in my bill.

My bill will authorize $1.5 billion to improve instruction in mathematics, science, and technology at the elementary, secondary, and postsecondary level. While providing support for school districts all across the country, my bill also targets the funds to those areas which need the aid the most.

The bill requires local planning and authorizes programs to train and retrain teachers, improve curricula, to develop improved instructional methods and materials, to acquire instruction equipment and to expand access to quality instruction in math, science, and technology. It will support similar activities in colleges and universities, as well as programs of research and development.

Finally, it will support the establishment of new math and science centers which will provide valuable resources to students and teachers at the elementary and secondary levels and will form the conduit between the researchers in the universities and the practitioners in the schools. This bill will provide a comprehensive, cooperative program to improve math and science education in our schools.

I am not unmindful that this program requires a major commitment of resources and effort, and no single institution or level of government can bear the burden alone. The Federal Government must provide the leadership. It must provide funds. It must provide guidance. But it must work with State and local governments, both financially and programmatically, in this effort. Nor can universities, libraries, museums, or businesses be forgotten. Together in a truly national effort, this Nation can make its public math and science education the best in the world.

I look forward to working with my colleagues on the committee and particularly my two good friends, Senators Pell and Stafford, to develop a bill on this subject agreeable to a majority of this committee and the Senate.

[Brief recess].

Senator **Stafford**. The committee will come to order. We see the Secretary has returned, which means that at least one member of the conference has survived for the rest of the meeting. [Laughter.]

Mr. Secretary, I want to say that I join with Claiborne Pell in saying to you that I think under very trying circumstances, under many of which probably you have been misunderstood by those who wish to misunderstand you, that I think you have really been a friend of education these last 2 years, and I join with Senator Pell in welcoming you here this morning as a friend of education who has done the best he can under the most trying of circumstances for the last 2 years.

And we would be very happy to hear your statement.

STATEMENT OF HON. TERREL H. BELL, SECRETARY OF EDUCATION, ACCOMPANIED BY CAROL CICHOWSKI, ACTING DIRECTOR, SPECIAL EDUCATION, REHABILITATION AND RESEARCH ANALYSIS DIVISION, DEPARTMENT OF EDUCATION

Secretary **Bell**. Thank you, Mr. Chairman.

If it is agreeable to the chairman, I will submit my written statement for the record, make a few comments and then be ready to respond to questions.

Senator **Stafford**. That would be most agreeable. We will place the written statement in the record in full.

Secretary **Bell**. Thank you. I know that the committee has heard in testimony the rationale for an initiative to solve the problem in the area of math, science, and technology. With the budget pressures under which the administration is laboring at the present time, the enormous concern about a deficit that could reach as high as $200 billion, and with a great amount of concern on the part of many in the administration about the initiation of a new Federal aid to education program in the face of all of these factors, the President has been very responsive to the data that we have presented indicating that this is a critical problem and that it is related to many priorities that we have in this administration.

Mr. Chairman, the administration's bill that Senator Hatch indicated was introduced yesterday, compared to the other bills, is a very limited and carefully targeted piece of legislation. The moneys available for this bill within the Department's budget had to be worked out within some tight constraints, constantly looking at this huge deficit that we are pondering. We felt that we needed to target the very limited resources that we could provide on the most urgent problem, and the most critical problem is the shortage of teachers. So, we have concentrated the full $50 million in our proposal on scholarships to provide and encourage the preparation of additional teachers in math and science.

We wanted a bill that would provide enough flexibility so that each of the 50 States could utilize these funds where the need is the greatest. We hope that our funds will be supplemented and enhanced both from State and local resources, limited as I know they are, and also from the private sector. We have analyzed the availability of secondary schoolteachers. We have studied some successful programs that have been piloted in some school systems at the present time, and we have concluded that if we can concentrate our resources on prospective teachers, those with college degrees, and those that have been teaching but do not have a teaching major in math or science, if we can concentrate our efforts on these potential teachers, we will be able to have a quick response to the need. And that is why we have focused our efforts in this regard.

As our bill is considered, we would urge that the committee keep in mind that the National Science Foundation budget and deliberations on their budget within the administration were taken into account.

NSF is going to be working in the precollege science field in both science and mathematics, in materials development, and in areas that will complement the focus of our bill—increasing the supply of teachers.

We have emphasized in our proposal the fact that the need is immediate. A survey that we conducted of the States and the school systems indicates that boards of education and State boards of education are dramatically raising the high school graduation requirements in these subject matter areas.

Because of this, the demand for teachers in mathematics and science on the high school level is increasing, and there is a decrease—I would not say a commensurate decrease—but there is quite a decrease and going to be quite a decrease in demand in other subject areas.

For one thing, high school enrollments are declining, and as students are required to take more mathematics and science courses, it just follows that they are going to enroll in fewer courses in other fields.

There is going to be an opportunity to redeploy teachers. In addition to that, with the high level of unemployment right now, there are others with college degrees who would be willing and capable of preparing for teaching. And so we have wanted to concentrate our resources in this area.

I would like to add just a few comments about some of the other math/science bills. If our legislation is not the legislation that moves forward, I think it is important that we concentrate on the number one problem. And the number one problem is to increase the supply of mathematics and science teachers. Admittedly, there are other things that we ought to be doing in addition to that, but my concern about the other bills is that the dollar amounts are in excess of what we can afford right now with the budget problems that we have. But if that is disagreed with and if we cannot persuade the committee on that item, we would emphasize, Mr. Chairman, that the provisions in the other bills do not concentrate a large enough portion of the total dollars and target them on bringing into the teaching ranks immediately more math and science teachers.

I would acknowledge that there are applicable provisions in the bills, those sponsored by you, Mr. Chairman, and Senator Pell, the bill sponsored by Senator Domenici, and the bill sponsored by Congressman Perkins and others in the House. But we do not think that they carry sufficient resources and they give sufficient priority to getting new teachers and retrained teachers into the classroom in a very short period of time.

There is both a long range and a short range solution. We would emphasize that our bill concentrates on the short range problem. And as limited as our bill is in dollar amounts, we emphasized this area.

We would urge the committee to take another look at that and see if whatever bill you markup and move forward, that our approach would get favorable consideration. But whatever bill does move forward, we would hope that we would get more emphasis upon meeting the needs for next fall and a year from next fall when we think the increase is going to be dramatic.

Just to put that in perspective, I would emphasize that our National Center for Education Statistics estimates for every increase in a course required to graduate from high school, you generate a need for 34,000 additional teachers.

Now, that is not allowing for the attrition and the loss that we are getting in the supply of teachers at the present time. And so we cannot emphasize too much the necessity for increasing the supply.

I am sure the chairman is very familiar with our bill and its orientation. With those comments and with that emphasis, I would be pleased to respond to questions.

[The prepared statement of Secretary Bell follows:]

Statement of

T.H. Bell, Secretary of Education

Before the

Senate Committee on Labor and Human Resources

Subcommittee on
Education, Arts, and the Humanities

Science and Mathematics Education

March 9, 1983

Secretary Bell is accompanied by
Carol Cichowski, Acting Director, Special Education, Rehabilitation and
Research Analysis Division

Chairman Hatch, Chairman Stafford, and Committee members. I appreciate this opportunity to appear before the Subcommittee on Education, Arts, and the Humanities to discuss science and mathematics education. I believe — and I know you share this view — that there are currently few topics in education which are more deserving of attention than this one.

Certainly quality in education is a concern in every field of study, and there is a pressing need to increase academic excellence at all levels. That is why I have created a National Commission on Excellence in Education to focus on the entire range of problems which face American education. The Commission's report will be published this Spring.

But science, mathematics, and technology have a very special importance in this country. They comprise one of the cornerstones on which our success as a nation is built. Our economic strength, our military strength, and our health and well-being depend to a very large degree on modern science and technology -- much of which has been developed by our own citizens. To maintain our strength and, indeed, our independence, we simply cannot afford to let our considerable skill in these fields degenerate.

The President, in his message last May to the National Academy of Sciences symposium on science education, and again in the State of the Union address, clearly and forcefully articulated this concern, saying that the declining condition of science and mathematics education has become serious enough to compromise the nation's future ability to develop and advance our traditional industrial base, and to compete in international marketplaces.

The problems are particularly severe at the secondary school level where there is a growing shortage of qualified science and mathematics teachers at the very time when many States and localities are trying to raise standards and increase enrollments.

- In a recent survey, for example, 43 States reported a shortage of math teachers, 42 reported a shortage of physics teachers, and 38 a shortage of chemistry teachers.

Yet, the supply of new science and mathematics teachers is dwindling:

- According to data from the National Science Teachers Association, during the past decade there has been a 79% decline in the number of individuals preparing to teach mathematics, and a 64% decline in the number of individuals preparing to teach science.

As our current science and mathematics teachers retire or, in too many instances leave teaching for other fields, it is very, very difficult to find qualified replacements for them. The problem will grow into a crisis because of another trend in education: State and local school boards are raising high school science and math graduation requirements. For example, since 1980 nine States have decided to increase the graduation requirements in mathematics, while another ten are also considering that as an option.

Our current requirements for high school graduation are too low.

- For example, a 1983 survey showed that only fourteen States require two years of mathematics, and only three States require three years.
- Other data show that only 38% of seniors report taking more than two years of mathematics, and nearly 5% report taking no math at all. Only one-fourth report taking more than two years of science, while 8% have taken no science courses.

As boards raise the requirements to increase students' competence in mathematics and science, the need for teachers will expand at an alarming rate.

Also, twenty-seven State universities have recently increased entrance requirements or have study commissions reviewing admissions standards, and most of these requirements are in science and mathematics. For each additional course required of high school students, we will need tens of thousands of additional teachers. Yet we do not have enough science and math teachers to meet even today's demands.

During the next two days you will be receiving detailed testimony on different aspects of science and mathematics education, so I don't think it is necessary for me to describe the situation at greater length. Clearly, the problems are important ones. America is still the technological leader of the world, but as the President observed in his State of the Union address, "We must keep that edge, and to do so we need to begin renewing the basics, starting with our educational system."

In response to these problems, dozens of bills were introduced in the last session of Congress related to science and mathematics education. Early in this session of the 98th Congress Senator Domenici introduced S. 248, the "National Mathematics and Science Excellence in Education Act of 1983." Senator Pell, Senator Stafford, and others have introduced S. 530, the "Education for Economic Security Act." H.R. 1310 was passed last week and has been sent to the Senate for consideration. Chairman Hatch, you have introduced the Administration's bill, S. 706, the "Science and Mathematics Teacher Development Act." I am pleased that so much interest has been expressed in this important area early in the session, and that your Committee, through these hearings, is focusing the attention of the Congress on the needs in science and mathematics education.

What is most urgent, in our view, is the necessity to forge an effective partnership with States, local education authorities, and private industry, so that each can do its part of the job. The Federal role must be a limited one -- and not only in financial terms.

It is States and localities which set graduation requirements from high school -- not the Federal government. I feel strongly that these requirements need to be raised in many districts if America is to maintain its technological edge. I applaud the efforts of superintendents, principals, school board members, and others who have recognized this early on and have set a standard others would be well advised to follow.

It is local school officials — not the Federal government — who establish teacher salaries. Data collected by the Department's National Center for Education Statistics show that the average teacher salary, in constant dollars, fell considerably during the 1970s. Now this is a problem for education as a whole, but it is especially a problem in math and science because business and industry offer technically trained people so much more money than education offers.

Furthermore, it is leaders from business and industry — not the Federal government — who ought to be the first offering assistance to those educators who want to understand our rapidly changing world of work, in order to implement relevant educational programs based on that knowledge.

It is in this context that the Congress is considering new legislation. The Administration's bill focuses on what I believe is the most critical element of the problem -- the growing shortage of qualified science and mathematics teachers at the secondary level in grades nine through twelve. In brief, the program would work as follows. Funds will be allocated to the States by formula to be used for scholarships for individuals not currently qualified to teach science or mathematics. Up to $5000 may be used for each scholarship. Eligible individuals must already hold a bachelor's degree, and must be able to become qualified to teach science or mathematics within one year. Prime candidates for these scholarships include teachers currently qualified in fields other than science or mathematics, and individuals with college degrees and interest and aptitude to teach high school math and science, but who need the academic preparation to do so. It is our intention to assist a large number of such individuals, and train them quickly. Our schools need these qualified teachers soon. That is why we would like to limit participation to individuals who are not now training to teach mathematics or science and who can qualify within one year.

In addition to the Department's initiative, the National Science Foundation is proposing to support activities in pre-college science and mathematics education. It is my understanding that the Senate Appropriations Committee is working with the National Science Foundation to develop an acceptable plan for use of fiscal year 1983 funds in science and mathematics education.

The proposed activities which I have described reflect this Administration's belief that there is an appropriate Federal role in science and mathematics education. Even with the budget restrictions under which we must labor in today's economy, we consider this problem of sufficient magnitude to justify an expenditure which we hope will be assisted by funds from State, local, and private sources.

But the Federal government cannot shoulder the entire burden. Because of our economic situation, we should be particularly careful not to enact new legislation which is excessively costly. Nor can we in Washington mandate solutions for States and localities, and so we must not pass new legislation which is overly complex and prescriptive.

In conclusion, I would urge you to concentrate on the most urgent problem. That problem is the critical teacher supply situation in these fields. Let's target our limited dollars there so we will get a maximum return. And let's look for results as quickly as possible. We must increase our pool of qualified teachers. Only with additional qualified teachers in mathematics and science can school boards raise local graduation requirements and enable the Nation to maintain its technological edge.

Thank you, Mr. Chairman, for this opportunity to express my views to this Committee.

Senator STAFFORD. Thank you very much, Mr. Secretary. I do have a couple of questions. Before I begin them, though, I am very happy that Senator Denton, a valued member of the committee has joined us this morning.

Senator Denton, do you have any opening statement you wish to make?

Senator DENTON. No, Mr. Chairman. I want to acknowledge your expertise, leadership, and initiative in this area, and greet my friend Secretary Bell, whom I have admired for quite some time. I am just developing the understanding that yours and his initiative would be a good bit broader than the rather, I would say, hastily contrived, but well intended administration bill. Is that generally an accurate statement?

Senator STAFFORD. Well, the Chair is not prepared to characterize any of the bills in front of the committee thus far. And the Chair would say to Secretary Bell that Senator Pell and I intend to work out a chart showing the salient features of all of the bills that have been placed in front of us and what they cost. And then we hope to work out from that as a basis what we would recommend to this subcommittee and eventually to the full committee, if the subcommittee agrees, as a bill to strengthen mathematics, science, and languages.

Senator DENTON. If the gentleman would yield, the question addressed whether or not the Secretary did not support your broader based bill. Would you mind my asking him that?

Senator STAFFORD. Well, I would prefer to get the questions in order, but I will certainly allow that one because I expect the Secretary, as a good secretary, is supporting the administration.

Senator DENTON. I have a Veterans' Administration meeting; that is the reason I appreciate the privilege of asking questions because I am going to have to leave.

Secretary BELL. We feel that the bill that you were referring to, Senator Denton, ought to concentrate more of its resources on the retraining of teachers who are not now teaching in mathematics and science areas, but that we think could be prepared to do so within a shorter time, if we would concentrate our funds in that area.

Secretary **Denton**. All right. Thank you. I did not mean to interrupt, Mr. Chairman, and thank you for that opportunity.

Senator **Stafford**. Thank you very much, Senator.

Senator Kennedy, we are very pleased you are here this morning.

Senator **Kennedy**. Thank you, Mr. Chairman; if you would be good enough to include my opening statement at an appropriate place in the record, as if read, I would appreciate it.

Senator **Stafford**. The subcommittee certainly will do that, immediately after those of Senator Pell, Senator Hatch, and myself.

Senator **Kennedy**. Fine. And I apologize to Secretary Bell for not being here during his presentation and welcome him back. I think the last time he was here I said this will probably be the last time he would be before the committee, but we are particularly fortunate to have him back.

Welcome. I hope you keep coming back.

Secretary **Bell**. Thank you, Senator, and I am pleased to be here, and it is a pleasure to appear before you.

Senator **Kennedy**. Are we into the question period?

Senator **Stafford**. I was just about to start them and stay on a 5-minute rotation basis, if that is agreeable.

Senator **Kennedy**. That is fine.

Senator **Stafford**. Being from New England, I always try to be short winded on these things. [Laughter.]

Mr. Secretary, in thinking about the bill that Senator Pell and I have introduced and some of the others that were described yesterday and are in front of the committee, my first question involves what I perceive to be a weakness in my own bill.

And that if we are successful in creating a substantial increase in the number of teachers for science, mathematics, and languages, how do we keep them in those teaching posts after we have succeeded in producing them? That seems to be a worry that has occurred to me.

Secretary **Bell**. That is a very critical question, and as I respond to that, I think I will provide some opportunities for my colleagues from NEA and AFT to respond.

I feel that our approach to compensating teachers needs to be modified by school boards. I have been urging that we have a good basic structure with a single salary schedule, but that we ought to be providing opportunities for teachers to gain distinction and recognition beyond that. I think until we do that, we are not going to be able to cope with the problem of attrition for teachers.

Now, I would readily emphasize that the basic salary schedule is too low, but whatever the level is, I think on top of that we ought to have some flexibility that can help to cope with this problem. Until we have that, until we have some changes in the way that we approach this problem, I think are going to continue to have this erosion of teacher supply.

I am aware of the difficulties and the problems that can be created if you start building into the salary structure that certain persons teaching in certain subject matter areas get more compensation. But for the 5 years I had before I came to this job, I was commissioner of higher education with a statewide higher education system. And we found it necessary to pay engineering professors and professors in medical school and others more money because the marketplace simply would not let them remain there if we did not.

And I think we need to work out some flexibility in that regard, although first of all, we ought to greatly increase the salary schedule because we are simply not paying all of the teachers enough.

Senator STAFFORD. Thank you very much, Mr. Secretary. All of our witnesses before the subcommittee on this issue have indicated that a comprehensive Federal approach is absolutely essential to deal with the many problems of mathematics and science education.

The administration's proposal for the Department of Education would provide $50 million, as you pointed out, for increasing the number and skills of teachers. Do you feel that this is sufficient as far as the Federal initiative is concerned?

Are there other activities the Federal Government might undertake to address these problems?

Secretary BELL. Yes. Well, in addition to that, we have the initiative in the National Science Foundation, but if you added both of them up, you would not come to a dollar commitment, I would freely admit, that is related to any of the bills that we are discussing.

I would explain, Mr. Chairman, that the problem that I faced in fashioning this bill is that I had to work within a certain budget allowance. And I had to consider what the impact would be if I put more money into this and had a broader based program on student aid, aid for disadvantaged children or for the handicapped, and so on.

In addition to that, we get to the philosophical question about what is the appropriate Federal role and what is the State and local responsibility. And we feel that the primary responsibility still remains with the State and local entities. Now, let me hasten to say that I know they are as hard strapped for funds as we are. But we felt, given the fact that all the money we could afford right now for this program was $50 million, that we ought to have the rifle shot approach.

And that is why we are proposing to target all of our resources on the teacher supply, teacher scholarship situation. And if I were to point out any deficiency in the other bills, I would say that they do not concentrate, even with more money, they do not concentrate as much money there as our much more limited bill does.

Senator STAFFORD. Thank you very much. I think the Chair will observe that we think you did very well in working through OMB and the administration to come up with $13.1 billion overall against about the $10 billion level that you had a year ago. And while this committee may not think 13.1 is enough, we do want to recognize the fact you really did a very persuasive job in getting the administration to come that high.

Secretary BELL. Yes. Thank you, Mr. Chairman. We need to give the President credit because he made the ultimate decision that we would not come forward at this time and propose cuts in student aid and aid to the disadvantaged and handicapped, those priority areas.

And I want to say before the committee that President Reagan was very supportive of me in the budget deliberations. I want to express my appreciation to him. It was not easy for him, Mr. Chairman, to come forward with a proposal for another Federal aid to education bill in face of all of the deficit problems that we are facing. It also shows where his priority is.

And I appreciated Senator Pell quoting from his state of the Union message on this.

Senator **Stafford**. Thank you. One more question and I will yield.

It is my understanding, Mr. Secretary, that you may be considering the possible transfer of a portion of your discretionary fund under the chapter II bloc grant to the Department of Defense.

Could you tell us if this is true, and if so, for what purpose should this be done?

This Senator, who believes our education budget is extremely slim, relative to the defense budget, would look with considerable disfavor, frankly, upon such a transfer. If you are considering doing this, could not your purpose be served within the confines of the Department of Defense budget itself?

Secretary **Bell**. Mr. Chairman, I have not given any consideration to transferring any of my funds anywhere. We are so hard pressed where we are with our resources. Apparently some member of my staff has been discussing that with someone besides the Secretary. There has been no such proposal put before me. And when it comes, it will be viewed with a very skeptical eye. We have so much demand on that discretionary fund that there is no discretion left in it. I cannot see where we would have any resources to send over to Cap Weinberger's department.

Senator **Stafford**. Well, that is a reassuring answer, Mr. Secretary. And I thank you.

Senator Pell, do you have questions?

Senator **Pell**. Thank you very much, Mr. Chairman. And I apologize for not being here to get the full benefit of your testimony. I will read it in the record. But we had another hearing down the hall in the Foreign Relations Committee.

In light of the situation we face in foreign language instruction, I was wondering why the administration called for the elimination of all Federal funding for international education and foreign language studies in fiscal 1984?

Secretary **Bell**. Yes. With the budget constraints that we had, I set out from the outset, Senator Pell, not to come before you with a proposed cut in student aid, not to come before you with a cut in education for the disadvantaged and for the handicapped, and as we related to these priorities, we made some painful choices.

Within the budget constraints that I operated under, I simply felt that the priorities were higher in other areas. Now, that is not to downgrade foreign language instruction, which I know is a great concern to many, but I felt within the constraints of the $13.1 billion budget I had to make some hard choices. This was one of them.

I would emphasize, Senator, that we propose and you dispose. And you may not agree with my priorities, but we hope you will agree with the total dollar amount so we can hold that deficit down.

But if you do not do that, then there may be areas where you would fund differently than I would, even within the limits of the budget that we have had.

Senator Pell. As I said earlier in my opening statement, I think we are very lucky, those of us who believe in education, that you are fighting the battle for education as well as you do.

Secretary Bell. Thank you.

Senator Pell. I know that you are doing your best. You have been quoted as saying that we must consider setting new maximum competency goals by students and our citizens of enhanced math, science, and computer literacy.

How would you define these standards? How would we get to them? I have noticed that in general education communities seem to dislike the idea of tests and performance checks. I agree with you in this.

Secretary Bell. Yes. I feel that we have been concentrating unduly on minimum competency examinations. I agree with the concern that we can have too much testing. As important as it is to have evaluation, it can surely be overdone.

I feel that we need more challenge for our gifted and talented and for even the midrange in ability student than we now have. So I have been emphasizing wherever I have had the opportunity to have the podium before education groups, that we need to not abandon our commitment to the disadvantaged and the handicapped.

Surely, with all the progress that we have made in that area, we need to hang in there and continue to make more. But on top of that, we need to be challenging, the able students more. And that was the point I was trying to make when I criticized minimum competency examinations. I think we need education that challenges every student to the full limits of their ability.

And I feel that if we do not do that in this highly competitive world, that we are not going to be serving our Nation as well as we should.

Senator Pell. Thank you very much.

Senator Stafford. Thank you, Senator Pell.

Senator Denton.

Senator Denton. First, I want to defer to my colleagues here in terms of their senatorial experience and, I think, devotion to duty in the educational field. I do not challenge that, nor do I try to pretend that I have similar expertise. In 34 years in the Navy, however, about a third of it was actually spent in school as a professor teaching or involved with my seven children's education in a private capacity. So I do have about 7 years of ongoing involvement in education.

I wanted to correct any misimpression that might have been derived from my original remarks. I do think that we have to keep in mind—and I know that colleagues at the table here disagree with me on this—that we may have a crisis in the first mandate assigned Government, that is, provide for the common defense, and to promote the general welfare, which was mentioned second, and with a less active verb, if you will, promote rather than provide;

indicates that the Federal Government is not the sole agency responsible, nor the primary one for the general welfare, and especially in the field of education. However, I do think that the expertise that you gentlemen have brought to this bill is broader and more relevant to the problem confronting us than the one which the administration has brought, and I do recognize, Mr. Secretary, that you had a limited amount of money to work with and would prefer to have a little more.

In other words, I want to say I do not necessarily approve of $400 million, but I think the amount proposed for this problem by the administration is probably not sufficient for the need.

I would like to say that I have a problem with both bills that have been discussed so far. Going from my own childhood until now and with what knowledge I have of education, which, as I qualified, is not as much as my colleagues on the subcommittee. I know that throwing money at the problem does not always solve it. From the point of view of the State of Alabama, it has not worked.

I watched that happen for about 9 years, both as a Senator and as someone on the Governor's commission on that subject. What is needed, I think, is some kind of emphasis on the common means by which you learn science, mathematics, computer education, foreign language, and that is an emphasis on the English language.

And I do not see that in any of these bills. And it appalls me because when I was—after returning to the States from an absence of some time, my son was teaching remedial English as a senior in a college to freshman students. I could not believe the kinds of papers that he was working with.

They were the equivalent of what I would have considered standard fifth grade papers when I was in school myself. Now, if you are going to study a complex scientific, technical subject with nuances of meaning which are implicit, you must have a mastery of the English language.

It seems to me that nothing has fallen off worse than proficiency in English, and that we should have some sort of emphasis in these bills. And I am just asking you and them if that is incorrect or do you agree, that we should have something?

I have seen accounts in the paper, in the newspaper in which there was mention that there would be emphasis on revivifying the emphasis on the English language in the basics. I find it chaotic and fundamentally responsible for some of the difficulties with respect to learning mathematics and science which are absent from this bill.

Can I ask you for a comment on that, Mr. Chairman?

Senator **Stafford**. Well, the Chair has two comments: The first one is not entirely serious, but I will say that Senator Pell and I appreciate your kind words about our alleged expertise in the area. And as one retired Naval officer to another, I would say that——

Senator **Pell**. And a Coastguard officer.

Senator **Stafford**. And a Coastguard officer. That if we were faced with docking a ship under difficult circumstances, we would certainly yield to you. [Laughter.]

As to your comments about the necessity for teaching of adequate English in our school systems, we would be glad to entertain any concrete suggestion you might have in connection with whatever bill that may emerge from this subcommittee. So we would be glad to make that part of our general discussion and general effort in terms of crafting a bill when we reach markup.

Senator **Denton**. Well, just one sentence, sir, and this would be my final comment. It says, Senator Pell's bill to provide program financial assistance to the States in order to strengthen—and my memo may be wrong from my staff—instruction in mathematics, science, computer education, and vocational education, and foreign languages. And it is all addressed at a math/science need, and so forth.

And I just wonder why the English was left out of it.

Senator **Stafford**. Let us consider that when we reach markup.

Senator **Denton**. Thank you.

Senator Kennedy.

Senator **Kennedy**. Thank you, Mr. Chairman. I think the Senator from Alabama has just made a case for this Nation's continued recognition of education as a local responsibility and of the important role for the States and the Federal Government in support of the local effects.

I agree with the Senator from Alabama that we do not solve our problems domestically by throwing money at them but I remind the Senator that we also cannot do it in the areas of national security either. And if we find ourselves with a functionally illiterate population, we are not going to have a very effective military operation, as well. I think that we should recognize that.

There are just a couple of concerns that I have, Mr. Secretary, in the areas of math and science. First, how are we going to make sure that this program does not become an elitist kind of a program? How can we be sure that math and science education gets out to all the students?

I have my own ideas and suggestions on this subject? I welcome the opportunity to work with the chairman of the committee and the ranking member, who have always been enormously responsive to any ideas that any of the members of this committee or the Senate, to achieve its objective.

Second, does it not make sense to provide these kinds of programs at the elementary and secondary school level and in colleges rather than to focus exclusively on secondary schools and colleges?

Secretary **Bell**. Yes. First on the elitist matter, I think the best encouragement we have that that is not going to happen is the fact that school boards all across the country and State boards of education are raising the requirements that are applicable to everyone, that they take more mathematics and more science.

I feel that a general upgrading—if you have to have 3 years of math, algebra I, and algebra II, and then, say, trig and geometry as a minimum to graduate—all students have to take that, then that is going to apply to all of them except those few that are so handicapped that they cannot study in this area.

I think that is the best assurance that we have. Now, in our most populous State, the State of California, their State board of education has just made some very dramatic recommendations in these increases. They do not just apply to the more talented students; they apply to all students as a requirement for graduation.

So there is a general upgrading going on there, Senator Kennedy. I am encouraged by that.

On the other point that you made, I would simply say that with the local board control as it is and with the commitment that I am seeing all over the country, we are going to see more resources being spent in these subject areas, and I agree that we simply must strengthen our math and science instruction in these areas all the way along the line. The reason the administration bill targets where it does is the limited amount of money that was available for it. But I agree, Senator, with what I thought was the leading implication of the question, which is that there needs to be a general strengthening on all levels.

Senator KENNEDY. I would hope that we would see that in the bill we report. I have not seen much of an indication of this as yet. Mr. Secretary, if you take the number of slots that are open, for example, for math or science teachers in this country or take the number of elementary teachers who are not trained to teach math and science, it is really appalling.

Secretary BELL. It is. I agree.

Senator KENNEDY. I think we are going to need to provide opportunities for elementary and secondary teachers to upgrade their own skills in these areas. I think that there is an important role for the Federal Government in providing these opportunities.

Mr. Secretary, can you tell us what your request of OMB was in this particular program?

Secretary BELL. This program evolved in the midst of our negotiations, after I had already received my budget allowance. We started with an initial allowance of $9 billion, and with the help of the President we got it up to $13.2 billion. After that we began work on the math-science initiative. We began to describe what the problem was, and how we ought to be showing our concern for this.

When the president agreed to it, the requirement was that we work it out within the confines of the $13.2 billion. So that was the problem that I had at the time. That in my original budget under the budget allowance, I did not propose this. I was not free to because we were still debating whether or not we were going to go for a new math-science initiative.

There are those that argue that there ought not to be any Federal assistance at all. So you have to swim upstream against that. You have to get the President to agree with you that he will support a new Federal aid to education initiative. And I was grateful that the President was willing to support us on that.

Senator KENNEDY. Of course, if you look at this initiative, the concern that many of us have is that you are talking $50 million spread over 50 States and 15,000 school districts. That works out to only about $1 per student. I think one of the issues is the dimension of the program and the dimension of our commitment. Is it really going to be a program of significance, or are we going to find out in another year that we tried this program and not been effective. Therefore, we would abandon it because we did not invest sufficiently in it.

We have gone over that in the past. My concern is that it is just spread so thin, so little. We are really going to raise expectations—false expectations—that this country is really trying to do something about math and science. Yet we will not be doing anything. I think that that is a matter of concern.

Secretary **Bell**. My concern, Senator, as I indicated before you came in, is that the No. 1 problem, in my opinion—and I think most agree with this—is that we have a terrible shortage of math and science teachers.

And in spite of the fact that some other bills go up to $400 million, none of them reserve and target as much money as our $50 million bill targets on scholarships to produce additional teachers.

So I think whatever bill passes, I would hope that we would target more heavily in that area than we now do. What you need, especially in mathematics, is a capable teacher and the text in the classroom. And we need more targeting on that, or all of the bills can be spread so thin, even the $400 million bill if we do place greater emphasis on that problem.

You see, ours is focused only on a new—I realize that this is subject to criticism.

Senator **Kennedy**. Yes.

Secretary **Bell**. But with limited money, we limited it to high school because that is where the shortage is and that is where the training is. You need to look at the high school population, and I suppose if you divided the 45 million students in the United States into the $400 million, you could shake your head and say, it is a pittance.

We have to concentrate and target our resources on the problem. And we have to recognize that this money is going to supplement and surely not supplant what State and local are doing in that regard.

Senator **Kennedy**. Finally, I welcome the chance for the educators to make the judgment with regards to the education budget. I think all of us understand that budget restraints exist, but I would hope that the educators will be making the recommendations, rather than OMB.

I do not expect you to make a comment on this, but I hear there are certain allocations, and it is usually by OMB, rather than by the educators in our society who by training and tradition and by concern and conviction should be making those decisions.

That is always a matter of concern.

Secretary **Bell**. I just observe that from an initial allowance of $9 billion, the President supported me in getting a considerable increase. I appreciate that and surely want to give the President credit for it.

Senator **Kennedy**. While, I am delighted that we are able to get some increase, I resent the fact that the OMB is making the decision with regards to these questions and that you are having to respond to that requirement.

If I could submit other questions, Mr. Chairman, I thank you for your indulgence and time.

Senator **Stafford**. Certainly, certainly.

Senator **Kennedy**. I would just like to point out for Senator Denton—and I regret that my colleague is not here to hear this—that the Constitution says, "We, the people of the United States, in order to form a more perfect Union, establish justice, insure domestic tranquility, provide for the common defense, promote the general welfare, and secure the blessing of liberty to ourselves and to our posterity."

The first words in the Constitution are "establish justice." And that includes social justice. That even comes before some of the other provisions. I think this committee has long been concerned about this and that education is extremely important in "establishing justice."

We welcome you, Secretary Bell.

Secretary **Bell**. Thank you, Senator.

Senator **Stafford**. Thank you very much, Senator Kennedy. And Mr. Secretary, as always, you have helped the subcommittee. You are always welcome here. I think you know that. And we appreciate you having taken the time to be with us this morning.

Secretary **Bell**. Thank you very much, Mr. Chairman.

Senator **Stafford**. The first panel that will join the committee this morning—and we would ask that they come to the witness table now—will be Mr. Willard McGuire, president, National Education Association; Mr. Albert Shanker, president, American Federation of Teachers; Dr. Patricia Graham, dean, graduate school of education, Harvard University, Cambridge, Mass.

Senator **Kennedy**. Mr. Chairman, I, too, would like to join in welcoming our panel here this morning. I think we are extremely fortunate to have this array of individuals to help us sort through this issue. I look forward to their testimony.

Senator **Stafford**. Thank you very much, Senator Kennedy. For the subcommittee, we welcome the panel this morning. We never have enough time here to do justice to the distinguished witnesses who join us and help us, and that seems to be true again this morning.

To try and stay on track, we do have that traffic signal system, which reminds me personally too much of driving in to work in the morning. But I am told it is timed for 4 minutes on the green, 1 on yellow, and then the 5 minutes has expired.

So we would ask you, if you can, to summarize your written statements. Your full written statements will be placed in the record as if read. And having said that, we would invite you to go ahead.

Mr. McGuire, do you want to go first?

STATEMENTS OF WILLARD McGUIRE, PRESIDENT, NATIONAL EDUCATION ASSOCIATION; ALBERT SHANKER, PRESIDENT, AMERICAN FEDERATION OF TEACHERS; AND PATRICIA ALBJERG GRAHAM, DEAN, GRADUATE SCHOOL OF EDUCATION, HARVARD UNIVERSITY, CAMBRIDGE, MASS., ON BEHALF OF THE AMERICAN EDUCATIONAL RESEARCH ASSOCIATION

Mr. **McGuire**. Thank you, Chairman Stafford and Senator Kennedy. I am Willard McGuire, president of the 1.7 million member National Education Association, which represents teachers, higher education faculty, and educational support personnel in all of the 50 States.

As a representative of nearly four-fifths of the Nation's public schoolteachers, and as a classroom teacher of math and Spanish, I appreciate and welcome this opportunity to comment on the legislation before this committee that is designed to improve instruction in math and science for our Nation's young.

We commend the chairman for holding these hearings on providing assistance from the Federal level to local schools and higher education institutions to develop an immediate response to science and math needs.

The problems and deficiencies in the area of math, science, and new technologies are growing to crisis proportion, and we owe it to our young people to respond now.

Today we stand at the crossroads. Public investment in education is being questioned at a time when studies have documented that scientific and technical learning, as well as communication in foreign language study in the United States have failed to keep pace with the phenomenal advances of the past two decades.

In fact, learning in these two areas has actually declined, and increasingly American youth across the land are not adequately prepared to take on the economic, technological, and national security challenges facing the Nation. In addition, there is a growing shortage of math and science teachers with chronic vacancies occurring in some areas.

Our concerns in this area are further documented in the appendix to this statement.

How should Congress deal with these problems? Three alternatives suggest the range of possibilities. First, the administration proposes taking $50 million out of chapter II Bloc Grant funds to establish a scholarship program for individuals who within 1 year's time could be qualified to teach math or science at the secondary level. This quick-fix approach merely puts a bandaid on the problem and ignores the need for better science and math instruction at the elementary level. And it provides no tools for planning and implementing a comprehensive program that will make all of education responsive to the total problem.

Second, the committee is considering S. 530, a far better approach that takes into account such additional areas as foreign language instruction, improved vocational education offerings, teacher training, and employment-based programs. And this bill authorizes $400 million a year for 3 years.

And third, there is the American Defense Education Act [ADEA] which is the most comprehensive program to address the two top priorities of the Nation today: economic recovery and national security.

ADEA provides incentives for local schools to improve the quality of education, especially in math and science, but also in foreign languages, communications skills, new technology, and to prepare students for employment, technical training, and for higher education.

How do teachers rate these bills? Mr. Chairman, the NEA has developed criteria attached to the appendix to my statement which provide an important evaluative framework for consideration of any math and science proposal coming before Congress. In this context, I would like to return to S. 530.

NEA criteria recommends that 95 percent of the funds be directed to the local education agency level. It is at the local level that the Nation's educational policy is administered and operated. And it is here that the need exists.

It is more cost effective to send funds directly to the local level than to channel them through a State bureaucracy. The 50-percent matching requirement in S. 530 would be a serious problem for the States which are experiencing extraordinary demands on their resources merely to provide the most basic services.

We believe strongly that a national problem of the dimensions we have outlined demands an adequate allocation of national resources. Funding called for in S. 530 and in the House-passed bill, H.R. 1310, is adequate for planning an initial program step, but not for a long range, comprehensive solution like the American Defense Education Act.

We understand and agree with the need for emergency programs, but believe that the depth and the scope of the issues before Congress today will require a long-term commitment of massive resources beginning at the federal level. NEA criteria call for administration of new legislation by the Department of Education which would coordinate programs in support of local efforts and initiatives.

Our criteria also specify that teachers working in close association with local school boards, business and labor leaders, and others interested in education develop and implement the best tailor-made, effective programs. We applaud the inclusion of a strong higher education component in S. 530, but recommend that the teacher training program in colleges and universities require joint consultation with local education agencies and teachers in the planning and implementation of the programs developed.

Several math-science bills now before Congress propose differential pay for teachers in these areas. NEA strongly opposes this approach as one that conveys a strong message to all teachers: that some subject areas are more important than others. After all, without reading and writing skills, no child can learn science and math. And this means, too, that education at the elementary school level must be taken into account in any initiative for improving math and science instruction.

We believe the answer is ADEA. And NEA members support the philosophy of the American Defense Education Act because it is a national program to meet the urgent national needs of improving instruction in math and science, communication skills, foreign language, guidance and counseling, in addition to reaffirming quality of access to education for all, it reinforces the concepts on which the Federal role in education has been built since the early years of the Nation.

ADEA establishes participation requirements for local school districts which choose voluntary participation in the program, and these include an assessment of both instruction and achievement in the elementary and secondary schools in the critical subjects, development of overall goals to prepare students for employment, technical training, higher education, and citizenship, including service in the Nation's defense.

And to measure the progress of the programs with ADEA assistance, local school districts will establish yearly evaluation systems developed with participation of the school board, administrators, teachers, parents, appropriate bargaining agents, business and industry, and the community at large.

During each fiscal year, school districts working with the ADEA program will be entitled to a basic payment of 2 percent of the average per pupil expenditure in the State. And those which can show substantial evidence that the program meets ADEA goals for the year will receive an additional 2-percent payment.

The summary and chart following the statement outline the basic program elements and estimated allocations to States during the first year of operation.

Mr. Chairman, at this time we urge that the assessment and needs analysis be commenced first. Further hearings and input can only assist in planning and implementation of an effective comprehensive program. NEA State affiliates are working with Governors in support of ADEA, and they would welcome the opportunity to offer their insights and recommendations to the committee.

We look forward to working further with the committee in the interest of developing a comprehensive, well financed program to attain the goal of better education to meet the challenges of this rapidly changing world.

Thank you.

[The prepared statement of Mr. McGuire follows:]

STATEMENT OF THE
NATIONAL EDUCATION ASSOCIATION
ON
MATHEMATICS AND SCIENCE EDUCATION LEGISLATION

I am Willard McGuire, President of the 1.7 million member National Education Association, which represents teachers, higher education faculty, and educational support personnel in all fifty states.

As a representative of nearly four-fifths of the nation's public school teachers, and as a classroom teacher of math and Spanish, I appreciate and welcome this opportunity to comment on legislation before this Committee that is designed to improve instruction in math and science for our nation's young.

We commend the Chairman for holding these hearings on providing assistance from the federal level to local schools and higher education institutions to develop an immediate response to science and math needs. The problems and deficiencies in the areas of math, science, and new technologies are growing to crisis proportion, and we owe it to our young people to respond now.

Today we stand at the crossroads. Public investment in education is being questioned at a time when studies have documented that scientific and technical learning, as well as communication and foreign language study in the United States has failed to keep pace with the phenomenal advances in the past two decades.

In fact, learning in these areas has actually declined and increasingly American youth across the land are not adequately prepared to take on the economic, technological, and national security challenges facing the Nation.

In addition, there is a growing shortage of math and science teachers, with chronic vacancies occurring in some areas. Our concerns in this area are further documented in the appendix to this statement.

How should Congress deal with these problems? Three alternatives suggest the range of possibilities.

First, the Administration proposes taking $50 million out of Chapter II block grant funds to establish a scholarship program for individuals who, within a year's time could become qualified to teach math or science at the secondary level. This "quick-fix" approach merely puts a band aid on the problem; it ignores the need for better science and math instruction at the elementary level, and it provides no tools for planning and implementing a comprehensive program that will make all of education responsive to the total problem.

Second, the Committee is considering S. 530, a far better approach that takes into account such additional areas as foreign language instruction, improved vocational education offerings, teacher training, and employment-based programs. This bill authorizes $400 million a year for three years.

Third, there is the American Defense Education Act (ADEA), which is the most comprehensive program to address the two top priorities of this nation today: economic recovery and national security. ADEA provides incentives for local schools to improve the quality of education, especially in math and science, but also in foreign languages, communication skills, new technology, and to prepare students for employment, technical training, and higher education.

How Teachers Rate the Bills

Mr. Chairman, NEA has developed criteria, attached in the appendix of this statement, which provide an important evaluative framework for consideration of any math and science proposal before Congress. In this context, I would like to return to S. 530.

NEA criteria recommend that 95 percent of funds be directed to the local education agency level. It is at the local level that the nation's educational policy is administered and operated, and it is here that the need exists. It is more cost effective to send funds directly to the local level than to channel them through a state bureaucracy. The 50 percent matching requirement in S. 530 would be a serious problem for the states, which are experiencing extraordinary demands on their resources merely to provide the most basic services.

We believe strongly that a national problem of the dimensions we have outlined demands an adequate allocation of national resources. The funding of S. 530 and of the House-passed bill (HR 1310), is adequate for planning and initial program steps but not for a long-range, comprehensive solution like the American Defense Education Act. We understand and and agree with the need for emergency programs, but believe the depth and scope of the issues before Congress today will require a long term commitment of massive resources—beginning at the federal level.

NEA criteria call for administration of new legislation by the Department of Education, which would coordinate programs in support of local effort and initiatives.

Our criteria also specify that teachers, working in close association with local school boards, business and labor leaders, and others interested in education, develop and implement the best tailor-made, effective programs.

We applaud the inclusion of a strong higher education component in S. 530, but recommend that the teacher training program at colleges and universities require joint consultation with local education agencies and teachers in the planning and implementation of programs developed.

Several math-science bills now before Congress propose differential pay for teachers in these areas. NEA strongly opposes this approach as one that conveys a strong message to all teachers: that some subject areas are more important than others. After all, without reading and writing skills, no child can learn science or math. This means, too, that education at the elementary school level must be taken into account in any initiative for improving math and science instruction.

The Answer is ADEA

NEA members support the philosophy of the American Defense Education Act because it is a national program to meet the urgent national need of improving instruction in math, science, communication skills, foreign languages, and guidance and counseling, in addition to reaffirming equality of access to education for all--the concepts on which the federal role in education has been built since the early years of the nation.

ADEA establishes participation requirements for local school districts which choose voluntary participation in the program. These include an assessment of both instruction and achievement in the elementary and secondary schools in the critical subjects; development of overall goals to prepare students for employment, technical training, higher education, and citizenship, including service in the nation's defense.

To measure the progress of programs with ADEA assistance, local school districts will establish yearly evaluation systems, developed with participation from the school board, administrators, teachers, parents, appropriate bargaining agents, business and industry, and the community at large.

During each fiscal year, school districts working with the ADEA program will be entitled to a basic payment of two percent of the average per-pupil expenditure in the state, and those which can show substantial evidence that the program meets the ADEA goals for the year will receive an additional two percent payment. The summary and chart following this statement outline the basic program elements and estimated allocations to states during the first year of operation.

Conclusion

Mr. Chairman, at this time we urge that assessment and needs analysis be commenced first. Further hearings and input can only assist in the planning and implementation of an effective, comprehensive program. NEA state affiliates are working with governors in support of ADEA, and they would welcome the opportunity to offer their insights and recommendations to the Committee.

We look forward to working further with the Committee in the interest of developing a comprehensive, well-financed program to attain the goal of better education to meet the challenges of this rapidly changing world.

Thank you.

THE AMERICAN DEFENSE EDUCATION ACT

Rationale

At a time when the challenges facing the nation's economic, technological, and defense needs are greater than at almost any other period in American history, the federal commitment to excellence in education, as well as a reaffirmation of the commitment to equality of access for all American people must be strengthened and reinforced.

Purpose

The American Defense Education Act provides that the federal government shall provide incentives to local school districts to improve the quality of instruction in the fields of mathematics, the sciences, communication skills, foreign languages, new technologies, and guidance and counseling, and to higher education institutions to bolster teacher training and support research and dissemination.

Summary

The bill:

(1) authorizes a national program to improve the quality of instruction in the fields of mathematics, the sciences, the communication skills, foreign languages, technology, and guidance and counseling, in addition to reaffirming equality of access to education for all;

(2) establishes participation requirements for the local school districts, which participate voluntarily in the program;

(3) provides for an evaluation of the progress of programs developed with ADEA assistance, which requires participation and input from the school board, administrators, teachers, parents, appropriate bargaining agencies, business and industry, and the community;

(4) provides for incentive payments for school districts working with the ADEA program of a basic payment of two percent of the average per-pupil expenditure in that state, (but not less than the average per-pupil expenditure in the United States), and provides those school districts which can show substantial evidence that the program meets the ADEA goals for the year with an additional two percent payment;

(5) provides that administration of the ADEA will be under the Department of Education, but calls on the Secretary of Defense to jointly project personnel training needs of the Armed Forces, as well as the educational needs of the Department of Defense to assist in efficient personnel development;

(6) provides higher education grants for teacher training initiatives such as summer institutes and workshops, inservice training, and projects to enhance their ability to meet new and practicing teacher needs;

(7) provides funds for college and university development of research and dissemination projects related to the purposes of ADEA; and

(8) authorizes payments based on the number of children enrolled in average daily attendance in local education agencies, multiplied by $50 in fiscal 1985, and by $100 in each of the two succeeding fiscal years.

Appendix A

Math and Science Concerns

Currently, American youth in the 15,000 school districts across the country are not adequately prepared to take on the economic, technological or national security challenges facing the nation. For example:

- Fewer students are taking fewer courses and spending fewer hours studying math and science.

  —A 1980 survey prepared by the Center for Education Statistics of a representative sampling of high school senior graduates in the U.S. revealed that only one-third of those sampled had taken three years of math or more. While more than half of academic students had taken at least three years of math, only a fifth of the general and vocational students graduate with three years of math.

  —This same Center for Education Statistics survey also revealed that only 41 percent of academic students completed three or more years of science courses, with 13 percent of general students and 9 percent of vocational students taking that same number of years in science.

- The growing shortage of math and science teachers has become critical.

  —There are only 10,000 physics teachers in the nation's 15,000 school districts.

  —An Iowa State University study prepared in the fall of 1982 showed that a survey of education departments in 45 states revealed that 40 state offices reported either shortages, some critical, or mathematics teachers, and 39 reported shortages, again, some critical, of chemistry teachers.

- The federal government's commitment to research and development, and to science education in general began to decline in the 1960's with support for graduate fellowships in science and math, and for teacher training institutes and curriculum development dropping dramatically in the last two decades.

- A study produced by the Electronic Industries Association showed that although the National Science Foundation has been receiving steadily increasing funding over the years' funding for science education has dropped significantly from 47% of the total NSF budget in 1959 to 7% in 1981, 2% in 1982, and a budgeted 1.4% in 1983.

Appendix B

Demographic Shifts

Some of the following demographic shifts will have a dramatic impact on our society for years to come:

- The Census Bureau predicts that our population will increase by 18 percent by the year 2000—jumping from the 1980 figure of 226.5 million to 267 million.

- The median age of Americans will climb from 29 in 1977 to 33 by 1990. By 2000, there will be more than 36 million Americans over the age of 65, and they will constitute more than 13 percent of the population.

- A "baby boomlet" is expected to occur through 1985, as the number of women between the ages of 18 and 34 moves from 32.1 million in 1979 to 33.9 million in 1985.

- Minorities will account for more than half the population increase in the next two decades because of high birth rates and immigration. By 1985, the non-white population will equal more than 22 percent of the total U.S. population, while white, non-Hispanic Americans will drop from 80 to 75 percent of the population.

- There will be a steady shift in population from the Frostbelt to the South and West, and in the Southwest, population growth will occur most among Hispanics.

- The number of women between 18-64 in the workforce will continue to grow. Over half of all women between these ages now work outside the home, and by the end of this decade, more than 70% are expected to do so.

Appendix C

The Impact of the Technological Revolution

The rapid changes in technology will only increase in the coming years, as will its impact on all American's lives. The following represent a few examples:

- The computer and its component industries are showing remarkable growth; this, in turn, will impact greatly on existing industries and skill requirements.

- Many routine jobs now performed by low skilled workers will be done by robots ten years from now. Jobs in these 'robotized' industries will require special technical skills, as well as more knowledge and autonomy by personnel in evaluating and responding to complicated technical information.

- The onslaught of the 'information revolution will create a need for workers with competency in computer literacy, statistics, perhaps a foreign language, and skills in engineering and the hard sciences.

- There will be a continued and growing demand for scientists, engineers, and technicians both within business and industry, and within the military.

Appendix D

Changing Defense Needs--Skilled Personnel Key

The most sophisticated weapons systems in the world obviously require the most sophisticated minds in the world to operate and maintain them. What this shows is the importance of highly skilled personnel to meet today's Armed Forces needs: A look at how skills needs have changed and what today's requirements are is relevant:

- In 1945, the Navy required that only 23 percent of its personnel be highly skilled, but by 1980, the role of semi-skilled personnel was sharply reduced, while the percentage of highly skilled personnel jumped to 42 percent. Currently, 70 percent of all Army jobs require some technical training, while 75 percent of Navy jobs require skilled or highly skilled personnel.

- Despite this greatly increased need for skilled personnel, the pool that the Armed Forces currently has to choose from falls short of those needs. In recent years, the military has been forced to rewrite its training manuals from the 11th-grade level or higher to the 8th -grade level or lower. Many are aimed at the 6th-grade level.

Appendix E

CRITERIA FOR ASSESSING MATH/SCIENCE EDUCATION PROPOSALS

- The proposal should be sufficiently comprehensive to include improvement of the quality of instruction in the fields of math, science, communication skills, foreign language, new technologies, guidance, and counseling.
- The proposal should provide for the planning and implementation of programs at the local level.
- The proposal should provide for local evaluation of the progress of program developed by funds from the proposal which requires participation and input from the school board, parents, teachers, appropriate bargaining agents, business, industry, and community.
- The proposal should establish participation requirements for local school districts which voluntarily participate in the program.
- The proposal should not advocate differential pay for any subject matter area.
- The proposal must provide for administration under the Department of Education.
- The proposal must provide for sex equity and equal access to programs.
- The proposal must provide for a research component to provide for improvement in teacher training methods, utilization of equipment, and classroom delivery methods and systems.
- The proposal must provide funds for the higher education community to jointly participate with local education agencies in preparation of the necessary number of qualified teachers to meet the need.
- The proposal's federal dollars for the programs must be directed to the local education agency for program delivery.
- The proposal's funding authorization level must be of sufficient quantity to provide a reasonable expectation of success on a national level.
- The proposal should require that the current level of expenditure for educational programs should not be reduced as a result of funding for the new program.

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Appendix F

The Shortage of Math and Science Teachers: The Problem, Some Solutions

NEA Staff Contributors:
COMMUNICATIONS
AFFILIATE SERVICES
I.P.D.
RESEARCH

The statistics are alarming.

- There were 43 states that declared a shortage of secondary math teachers and 42 states said the same about science teachers.
- The number of college students prepared to teach high school math has dropped in the past decade by 77 percent. For science, it is down 65 percent.
- According to a University of Iowa study, more than half of newly employed math teachers nationwide have been employed on an emergency basis because school officials could not find qualified teachers. In California alone, during the 1980-81 school year, licensing agencies issued 19,000 emergency credentials.

The conclusion is obvious: Our nation's public schools face a critical shortage of math and science teachers. And as a result, students in this technological era do not have the opportunity to learn skills that are becoming more crucial every day.

One cause of this teacher shortage is industry's success in "out-bidding" the public schools for the skills and expertise of people proficient in those subject areas. In the 1980-81 school year, for example, the beginning salary offered to bachelor degree candidates in mathematics-statistics was 86 percent higher than the average beginning salary for public school teachers. Even more appalling is the fact that in 35 states today the average salary paid to all teachers—half of whom have an MA and more than 11 years' experience—is lower than the salary that industry offers to brand new math-statistics graduates.

Translating these statistics into dollar amounts means a new teacher with a bachelor's degree earns $11,758. If that same person used his or her skills in computer science, the salary would be $18,864. If he or she became a mechanical engineer, it would be $22,584. And so it goes.

The fierce competition for talented and qualified personnel is escalating as industry tries to win over would-be teachers—and many teachers now in the classrooms—with superior salaries, benefits, and working conditions.

One of the solutions to this crisis now being seriously considered is the use of differential pay to attract and hold teachers in math and science, that is, to pay teachers of those subjects more money. NEA emphatically opposes this idea., Historically, the Association has worked for salary schedules that are based on objective criteria and that offer equal pay for similar work.

All teachers perform the same basic function in their jobs. Teaching is based on a core of educational principles and calls for its practitioners to use similar skills—whether they happen to be art or history or science teachers. NEA believes then, that teachers' salaries should be based on the formal level of professional preparation and teaching experience, not on the teachers' sex or race or even the subject or grade level taught.

Paying math and science teachers on a higher salary scale suggests that those academic disciplines are more important than other subjects. Even the scientific community would hesitate to make such an arrogant and pedagogically unsound assertion.

Added-pay schemes fail to take into account two fundamental considerations: why people enter teaching and why they remain in it. Virtually every available study shows that people enter the field primarily because they want to work with young people. The same studies reveal that many leave because of inadequate time to teach and because of other factors that are not directly related to salary. Obviously, salaries for all teachers must be raised, but there are other ways of making teaching more attractive than simply paying more to teachers who are—perhaps only temporarily—in short supply. Class size must be made manageable, nonprofessional duties must be reduced, and teachers must be given time to pursue courses and other professional development activities to help them improve their teaching and their sense of self-worth. These changes cost money, but money that will aid all teachers—and students—not only a select few.

Richard Duschl of the Maryland Association of Science Teachers does not think differential pay can be justified from another point of view: workload. "In terms of time on task," he says, "English teachers have the heaviest workload. How can you say one area is more important than another?"

Even if it would alleviate the math and science teacher shortage, the proposed solution creates more problems than it solves. One would be deciding *who* would get the supplement. Only teachers of advanced high school mathematics such as algebra, trigonometry, calculus? What about the elementary and middle school teachers who teach math and general science (and thus prepare students for advanced courses) as part of their regular day?

An additional thorny issue is how much money it would take to induce teachers to enter—and remain—in the classroom. Should the pay be comparable to salary offers being made by private industry? If so, where would the money come from? From funds that could otherwise be used to improve salaries for all teachers? The Houston, Texas, schools are offering newly recruited teachers in science and math $2,000 more than other new teachers. This incentive, however, only begins to bridge the $5,500 starting salary gap between private employment and teaching.

But an even more critical issue is how differential pay would affect morale in the public schools. Everyone understands the symbolic significance of pay as a measure of status in the workplace and in society as well. What would school boards who pay math and science teachers more be saying to their elementary teachers, to their foreign language teachers, to their counselors and librarians? How would they defend the inequities?

Favored status for a few teachers would likely undermine the cooperation and collegiality among *all* critical ways in which a faculty works together for the good of students. Math and science teachers—who perform the same function as those in other disciplines—would be set apart and viewed as a privileged class.

"If there's a caste system within our own faculties," says Gerald Piel, publisher of *Scientific American*, "we're not going to get their (teachers') concerted effort to do what's best for growing young people. It's vile to have the market process from the outside tearing the education community apart. In a civilizied society for industry to have first claim on our country's talent shows something is wrong. Where's the value put on the arduous task of education?"

Clearly, alleviating the shortage of math and science teachers does not lend itself to a quick-fix solution or a snappy panacea. So rather than focusing on this superficially attractive suggestion of differential pay, we would do better to look at more carefully thought out, productive approaches to solving the problem.

What alternatives does NEA endorse? The answer is that the Association will support ideas which square with the principle of equal pay for equal work and equality of educational oportunity for all students. Such ideas must be funded without significant impact on the funding for both salary and nonsalary improvements for teachers generally.

One obvious solution is to "reeducate" today's surplus teachers to fill the math and science vacancies. As a result of tight school budgets and declining enrollments, many excellent teachers have lost their jobs. Particularly affected have been beginning teachers, those in their first years of employment. So why not tap their talents and commitment to help fill the math/science gap?

It's unrealistic to assume that any RIFfed teacher would want to or even feel comfortable being retrained as, say, an advanced science teacher. training might work. A social studies teacher, for instance, might prepare him or herself to teach general science—and the general science teacher would get additional training in order to become certificated in physics or chemistry.

Who would pay for this additional schooling? There are several possibilities. One is for the local districts or states to offer grants to teachers willing to expand their areas of certification. Another is more federal support for math and science education.

The federal government's commitment to science education, research, and development has been declining since the late 1960's. In addition, federal support for teacher training institutes and curriculum development dropped off dramatically in the 1970's and virtually disappeared in the ensuing years.

One excellent program that has been hurt by recent federal budget cuts has been the National Science Foundation's summer institutes for math and science teachers. We should be providing more, not fewer, opportunities like this to our public school teachers.

The NEA-backed American Defense Education Act (ADEA) would be another good way to meet the shortage of math and science teachers. It would also bring new information about math and science to the public schools across the country.

Senator Gary Hart (D-Colo.), chief sponsor of the ADEA in the Senate, says the intent of the bill—as with the National Defense Education Act in 1958—is to help schools improve critical education programs in mathematics and science, as well as in foreign languages, guidance and counseling, and the new technology. One component of the bill deals with in-service training for teachers which could be used for those who are willing to renew and expand their expertise.

If we expect to increase the number of math and science teachers in the years ahead, we must start promoting the idea now with today's high school and college students. Cancellable loans or scholarships to defray the cost of college education in math/science would be an incentive to enter the field. There could be a stipulation that accepting the money means spending a specified number of years teaching math or science in the state and that the recipient must reimburse the state if this condition is not met.

Some incentives to draw and keep math and science teachers in the public schools could apply to other teachers as well. Many teachers would benefit, for example, if industry employed more teachers during the summer in their fields of interest. Many teachers would welcome the change to interact with their professional colleagues, update their knowledge base, and enjoy the security of guaranteed income for the summer.

Plans to address the present problem should not ignore the demands and desires of one group that has a vested interest in the public education system—namely parents.

Teachers in all subject areas could both help their own salary crunch and demonstrate their responsiveness to parental concerns by instituting summer tutoring programs. Many parents would like their children to have the chance to gain extra skills or get help in a weak subject area. Local school boards could support the program by providing office space and secretarial support, as well as by officially endorsing the effort.

While recognizing the critical shortage of math and science teachers, we must also realize that the problem doesn't end there. Inadequate salaries are forcing teachers in all subjects to seek jobs where they feel their efforts are being fairly compensated and their profession given due recognition.

Comparisons of teacher salaries to those paid other workers with similar education and training show that teachers in most parts of the country are underpaid by thousands of dollars a year. No wonder, then, that dedicated teachers in *all* fields are leaving the profession for higher paying jobs.

We have not paid our teachers adequately up to now. For years we've had a captive job market among the best, the most intelligent women. Among the best, the most intelligent blacks and other minorities. These groups had few other job options—education was one of the most attractive careers open to them. But now the barriers to other professions are beginning to come down. So we must entice these people into the teaching profession, pay them enough to keep them there, and provide support and recognition commensurate with their contribution to the nation's children and the nation's future.

Senator **Stafford**. Thank you very much, Mr. McGuire. Mr. Shanker, would you go next, or should Dr. Graham go next?

Mr. **Shanker**. Fine. Thank you very much. Mr. Chairman and members of the committee, I am Albert Shanker, president of the American Federation of Teachers. We represent and have membership of just under 600,000 across the country, mainly in elementary, secondary, and higher education, but also in health care and civil service professionals.

We welcome the committee's interest in facing some of the major problems in the field of education today, especially with the current emphasis and interest given to the shortage of teachers in the fields of mathematics and science. These shortages were easily predictable some years ago when the number of people entering into teacher training in general and specifically in math and science was in sharp decline—for quite a number of years; but we tend not to look at problems until it is quite late, and it is very late now.

I would urge that along with the attention that we are giving to mathematics and science, that we start paying attention now to the fact that in just a few years we will be sitting in this room or one like it discussing similar shortages in almost every area of teaching.

Furthermore, the problems that we have in producing mathematics and science teachers cannot really be separated from the quality of education in general. The national assessment recently has given us some very interesting and important evaluations showing that when it comes to adding or subtracting, multiplying, dividing, when it comes to very basic, fundamental operations, we have done pretty well over the years and the overwhelming majority of students who go through our schools do well.

The minute you move over to something that is a verbal problem that takes more than one step, even if the numbers are really very easy and even if the numbers are precisely the same numbers that they would be able to do if all they had to do was add or subtract, you fall down from an 85- or a 90-percent level of competence on the simple calculation down to a 20- or 30-percent level in the ability to think problems through, even simple problems.

I would submit that the thought process involves many verbal skills, and it involves skills that are not taught in math and science alone, and therefore we should be thinking of solutions that are somewhat broader than those before the committee. Now, in dealing with this problem, unfortunately what we are trying to do what we frequently try to do and that is try and get a very quick fix for something that has been neglected over a long period of time and will only be solved, if it is solved at all, over a long period of time.

And I would like to spend my remaining few minutes talking about some of the things that we ought to be doing, both in the long run and in the short run as well. Because in the absence of being able to solve the problem instantly, a quick fix, even if inadequate, is better than doing nothing at all.

I would like to spend a good part of my time on an area of this problem which I think has been largely neglected in the entire discussion, and that is that most analysis of the problem deals with what we are doing in teacher training institutions. That is fine; or what we are doing in terms of colleges and universities, providing enough people. That is all right. And then some attention is given to what happens at the high school level. Whether we are offering enough algebra or geometry or trigonometry or other courses.

I think that examining only those levels will not produce any satisfactory results. To solve our long-range problem we must take a look at what is happening in our elementary schools. Now, we allow students to leave elementary school and go to secondary school, even if they have totally failed in understanding and achieving in the whole area of mathematics and science.

They move right on. And then you can go through high school and you can graduate high school, again, without developing any competencies in these areas. And you can certainly enter college and graduate college and become a teacher without ever developing skills in math and science.

Now, maybe there is no terrible loss if someone goes through this path and ends up an English teacher or social studies teacher, although I am sure if they knew some math and science, it would be helpful. But—and we assume that math teachers who have gone into that field have some interest and some competence in their subject. Although I would feel better about it if we tested them before they entered teaching.

But what I am very sure of is that a very large number of elementary schoolteachers are those who went to elementary school and high school and college and really never understood arithmetic. Let us forget about any mathematics above that. And since our elementary schools are organized on a self-contained classroom basis, it is quite possible that the children of America have a teacher once every other year or once every third year who himself or herself really does not understand simple arithmetic.

Now, unless we correct that, we are producing elementary school graduates who move into secondary school who have only had half of the mathematics and arithmetic that they are supposed to have had throughout their elementary school.

And what has happened is that we have already lost the battle because we have students now who are 3 or perhaps 4 years behind. I would very strongly suggest, therefore, that as the short-term priority—at least one short-term priority be the provision of summer and other training institutes for those who are now teaching in elementary schools and who feel that they could use some additional assistance to improve their teaching.

And I am sure I will have an opportunity during the question period to raise some of the other points which I make in my paper.

Thank you very much.

[The prepared statement of Mr. Shanker and additional material supplied for the record follow:]

STATEMENT OF ALBERT SHANKER, PRESIDENT
AMERICAN FEDERATION OF TEACHERS, AFL-CIO
BEFORE THE SENATE SUBCOMMITTEE ON EDUCATION
UNITED STATES SENATE
March 9, 1983

I am Albert Shanker, president of the American Federation of Teachers, AFL-CIO. The AFT represents more than 580,000 elementary and secondary teachers, school paraprofessionals, health care professionals, civil service employees and university professors. We are deeply concerned with this problem and grateful that this committee recognizes that it requires federal attention. We are appreciative that you have given the American Federation of Teachers the opportunity to express its point of view.

Before addressing the specific proposal you have before you, I think it would be helpful if you first had a sense of how we view this issue. This presentation will be necessarily brief, but it is based on two more extensive documents which I ask be included in the permanent record of this hearing. One is a spot survey of what is going on in key AFT states and local districts. The other is a more extensive analysis of what needs to be done.

First of all, we believe that to tackle the problem of quality in math and science is to tackle the problems of education generally. In dealing with the math and science teacher shortage we have to face the problem of teacher recruitment and quality generally. The questions we ask at every level of government and the answers we offer will ultimately shape our entire system. We must be sure we ask the right questions.

The AFT also believes the federal government has a role to play in solving the problems that we are examining today. These hearings must produce a commitment of federal dollars and leadership towards solving the shortage of math and science teachers. The problem is nation-wide and so must be the solution.

We must start by recognizing that with the economy in the midst of a near depression, public education is caught up with the need to defend itself in economic terms. The crisis in school financing captures the attention of all who are working for a quality system of public education. On top of this financial crisis is a second crisis of national scope and that is the wearing out of the nation's infrastructure and of the erosion of our country's position as the world's leader in science and technology and our decline as a world economic power. While public education should never be geared to react solely to immediate problems, to ignore these problems would be a disservice to our country and the nation's children.

Within this context, the crisis in math and science education is beginning to get the attention it deserves. Student test scores are down in these subjects. Curriculum requirements are often minimal and do not compare well with those of this nation's economic competitors. Students lose interest in these subjects early and fall away from them as soon as school course requirements permit. To compound the situation, severe teacher shortages are emerging in both subjects in all but a handful of our states, largely because of the failure of teacher salaries and job satisfactions to compete with those in the private sector.

Some have taken the popularity of the economy-education connection as an indication that fitting education specifically to future job skill requirements is the best way to keep the educational enterprise and the demands of the economy running in tandem. But even if this were the sole purpose of education, which it is not, from the reports we have examined and the experts we have talked to, we have come to the conclusion that deciding on which specific job skills would be impossible. Experience has already shown that it is hopeless to try to predict labor market skill demands with an exactness. The economy is simply too large and subject to change on very short notice. In fact, in the future many believe that everyone will be required to function in many jobs due to the demands of rapid job market change. The best job skill will continue to be an education that focuses on developing intellectual skills and the ability to adapt to new circumstances. This is an important premise if we are to solve the math and science crisis because many are examining the problem with invalid assumptions such as:

- Since high technology is growing (to what degree and at what pace are also debatable), the main concern of business with math and science stems from its interest in having a select group of students prepare for advanced education and training:
- Since math and science become defined as specific subjects at the high school level, this is where to focus all the attention:
- Because math and science are regarded as preparation for more advanced education, their decline is a "pre-college" problem rather than one for general education at all levels, including the elementary grades.

There is good evidence that all of these assumptions are wrong. But, unfortuantely, many believe this analysis of the problem and they are producing initial responses that concentrate on college preparatory students, ignore the importance of the early grades, and wrongly interpret business wisdom on the subject.

There is one other dimension to the economic-education relationship worth mentioning here: demographic patterns add additional considerations to any evaluation of the importance of math and science education. The U.S. Census predicts that within the next twelve years there will be more than a 25% reduction in the number of 18- to 25-year-olds. At the same time, the proportion of this age group likely to be from non-English speaking and disadvantaged backgrounds will rise dramatically. The likely outcome of all of this is that competition among business for the better performing students will increase at every employment skill level. The more these less advantaged students are grounded in math and science, as well as, in other intellectual skills the more prepared they will be to function in our changing economy.

I am not going to go into an extensive description of the math/science problem here. That information is already on the publc record and is covered in detail. It will be in the supplementary material we are submitting.

I will try to indicate briefly why we put our emphasis where we do. We believe that the most important change in the current direction is to put far more emphasis at the elementary and secondary level. Current solutions seem to be aimed at aiding those who might already be described as select students with well developed math and science capabilities, new emphasis must be placed on raising the level of math and science capabilities for all students and teachers.

THE EDUCATION ISSUES

For many of the economic reasons indicated above, and because of the requirements for a broadly informed citizenry able to deal with complex questions, we contend that all students should get more math and science. There is no national thrust to establish why math and science are important to the general education and why math and science literacy must be developed in the early grades. Nor is there a needed examination as to why all students should develop what John Dewey called, "scientific habits of mind," no matter what direction their future employment takes.

Right now, this issue is often being advanced politically by specialty groups who are understandably more concerned with math and science education for future scientists and mathematicians. And at the federal level, at least, this is highly convenient for an administration that would prefer to spend as little money as possible on a few select, visible programs. To really address the problem comprehensively costs more than the present administration cares to spend on public education. The AFT bases its solution to the problem on two points:

* That school districts be encouraged and assisted in efforts to upgrade and add offerings in math and science. And that local education agencies will be pressed to tighten graduation standards for all high school students. While this is not a federal matter, we think it important to the federal government's interest in this matter, that school districts get help in dealing with those new problems.

* The elementary school level is extremely important and is now being virtually left out of the national discussion on this problem. The future math and science competency of the nation may depend on whether we put proper attention on elementary schools whether it be resource updating, access to computers, time spent on the subject matter, or upgrading the skills of elementary school faculty.

THE TEACHING FORCE

A teaching force to match these priorities will not be easy to come by. Our AFT survey points to two broad problem areas, as do most of the other data now available. First of all, people are not entering teaching in these fields in adequate numbers. The figures are well known. We think the major reason is inadequate teaching salaries. Without adequate salaries to attract talented people, it will be difficult to turn this trend around and, though, we realize that the billions required to make teachers' salaries competitive are not likely to come for the federal treasury, this problem will hamstring any effort to solve the shortage.

Secondly, even with those teachers already on the job, there are large numbers who are teaching out of their license or certification area with emergency credentials and sometimes just off the record entirely.

Finally, we note once more the lack of attention being focused on the importance of the elementary school teacher, even as these teachers acknowledge their insecurities in these fields and the unavailability of opportunities to improve themselves.

We ask for:

- Large-scale efforts at retaining on-the-job teachers, both those already certified or licensed and those seeking new qualifications in math and science. Retraining should also be available to those facing layoffs. Such efforts should involve special institutes, including summer institutes, and the use of other forms of inservice support.
- Special measures aimed at elementary school teachers which might include much of the above but would be specifically geared to their needs. At the elementary level there is need to upgrade all teachers in math and science skills, as well as to consider the supplementary use of subject matter specialists. No single solution will solve the problem.
- Provisions aimed at longer term recruitment, including scholarships and loans with forgiveness provisions that would allow loans to be cancelled for years spent in teaching. We would also like to see more outreach and counseling for high school students to urge some of the more qualified to enter teaching.

Our program priorities, then, are concentrated on: (1) upgrading curriculum for all students at all levels; (2) placing new emphasis on the importance of the early grades in teaching math and science; (3) retraining on-the-job teachers, again, with special emphasis on the early grades; and (4) recruiting new teachers with special scholarship and loan programs. While no long term solution for math and science teachers, and indeed, for all teachers, can fail to come to grips with the need for higher teacher salaries, we see the measure we have pointed to as the most productive focus for the use of federal funds.

What should federal legislation seek to accomplish? Ideally, we would like you to come up with a method of putting federal dollars on the most important problem, qualified teachers, and that means recruiting. We also believe that districts and states should upgrade math and science curriculum standards. The only way to accomplish this where you have people teaching out of certification areas or with minimal standards is through retraining. Money should be focused to school districts with this form of shortage, or they will not have any incentive to upgrade their curriculum standards since that will simply exaggerate their staffing problems. Unless the federal government can put some money behind teacher retraining, all the talk about higher standards and higher graduation requirements can only amount to wishful thinking. We know you recognize teacher training as a priority for legislation, we believe it should have the highest priority.

In addition to the targetting issue and the need for a special emphasis on retraining, we support the use of competitive scholarships as one way of recruiting new people. Such a program should not be symbolic, nor should it have any particular relationship to elected officials, or be chosen by political appointees along with elected officials. It should truly be an attempt to attract the very best people available. We also urge you to consider loan programs that include forgiveness provisions for years served in teaching. Of course, a more extensive scholarship--one based exclusively on merit--would be to our liking, as well.

We also support the establishment of summer institutes and workshops for teachers. We would hope funds could be specified for institutes that would meet the unique needs of elementary school teachers.

Likewise, we would urge that some attention to the elementary level be established by supporting research on elementary school problems. It would be counter-productive if research were limited to secondary school or post-secondary problems as seems to be happening at this time.

While considering research, I must point out that it certainly would be helpful to have a clearer picture of how the teacher shortage, teacher recruitment prospects, efforts to upgrade curriculum standards and in-service education actually combine at the local level. No national research, to our knowledge, actually gives a good national picture of how these variables interact locally. This is one of the reasons we ended up doing our own spot research. Such information would be very useful to have now when we are grappling with the funds distribution problem. Certainly it should be part of your future deliberations.

Let me conclude by saying that we are pleased the committee is making this effort. We welcome its recognition that solving the math and science problem is a matter for the federal govenment to address. We do not think the amount of money being considered is adequate to solve the problem. We believe that the purposes of all the bills considered should be specific and subject to evaluation of what really is achieved through the federal government's initiatives.

We assume you agree with us that the math and science problem is not just a pre-college problem and that whether it is the demands of the labor market or of our nation's need for a well-educated citizenry, we should make math and science matters of general concern for all students, future job-seekers and voters alike. This means we require more teachers and higher standards at all levels, from the elementary (even preschool) years right through high school. It is appropriate that the federal government help public education with those goals and do it in such a way that the public can see how the money is spent. We believe that what we have suggested makes that more possible.

Thank you very much for considering the views of the American Federation of Teachers, AFL-CIO.

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United States Senate
COMMITTEE ON LABOR AND
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WASHINGTON, D.C. 20510

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Shanker.

March 10, 1983

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MAR 11 1983
PRESIDENT'S OFFICE
AFT-AFL-CIO

Mr. Albert Shanker
President
American Federation of Teachers
11 Dupont Circle
Washington, D.C. 20036

Dear Mr. Shanker:

I very much appreciate your testimony on the problems of mathematics, science, and foreign language education before the Subcommittee on Education, Arts and Humanities. I apologize for our severe time constraints and interruptions which may have precluded full discussion of the issues raised during your testimony, and thank you for your patience.

As I mentioned during the hearing, I am submitting to you, for written response, questions related to your testimony and to other issues of concern to the Subcommittee. In order that we may have the benefit of your views prior to the Subcommittee markup of this legislation, I would appreciate it if you could respond to these questions by Tuesday, March 22. Please direct your responses to the attention of David Morse of my Subcommittee staff, SD-428 Dirksen Senate Office Building, Washington, D.C. 20510.

Again, thank you for your useful testimony, and for your help to the Subcommittee.

Sincerely,

Robert T. Stafford

Robert T. Stafford
Chairman
Subcommittee on Education,
Arts and Humanities

RTS:DMt
Enclosure

1. Are there any potential pitfalls in a comprehensive Federal mathematics and science education initiative? Do we neglect other essential subjects if we make a particular effort in these discrete subject areas?

2. If we are speaking of a maximum level of funding of no more than $500 million, do we seriously dilute our effort if we require funds to be passed through to all school districts within a State?

3. Most of the legislative initiatives proposed address the problems of teacher supply and quality. Are there any learning programs - programs for gifted students, magnet schools, programs targeted at special populations - that should be incorporated into a legislative proposal?

American Federation of Teachers AFL-CIO
11 Dupont Circle, N.W.
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(202) 797-4400

ALBERT SHANKER
President

April 13, 1983

The Honorable Robert T. Stafford
U.S. Senate
133 Hart Building
Washington, DC 20510

Dear Senator Stafford:

This letter constitutes my reply to the questions you forwarded to me in March. I regret the delay in responding. I hope it is not too late for you to include this letter in your permanent hearing record.

Your first question asks if there are potential pitfalls in a comprehensive math and science initiative; I believe that while there are potential pitfalls, the need for such a Federal effort makes taking a little risk justified. I do not believe that a comprehensive program for science and math will cause us to neglect other essential subjects. Rather, a Federal effort in science and math could compliment existing Federal efforts towards the ultimate goal of educational excellence. For example, ESEA I of the Elementary and Secondary Education Act, provides most of its services to the teaching of reading and math skills, the efforts are largely remedial for children who are below their appropriate grade level in achievement.

A comprehensive math and science program should be enacted and implemented with a goal of providing additional exposure to science and math for all children.

In regard to your second question for distributing funds, I believe that requiring funds to be passed out to all school districts would seriously disperse Federal efforts to improve science and math to the point of ineffectiveness. The position of the American Federation of Teachers is that Federal funds should be concentrated on areas of the greatest need. We believe that using the ESEA Chapter I formula for the distribution of funds would result in dollars going to the areas of greatest need.

Your final question was in regard to the type of learning programs to be supported. We believe that the most important learning program that should be supported by Federal efforts would be one aimed at elementary schools. Programs for gifted students and magnet schools already attract and serve the students they are designed for. These are usually students who would pursue math and science studies regardless of Federal efforts.

However, a serious effort to raise our national literacy in math and science must begin with elementary schools. Only by requiring math and science courses for elementary schools students and especially for women and minorities can we begin the process of increasing the number of our high school and college students enrolled in science and math courses.

If any further information is required, please let me know.

Sincerely,

Albert Shanker

Albert Shanker
President

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AFT REPORT ON THE MATH/SCIENCE TEACHER SHORTAGE, CURRICULUM STANDARDS, BUSINESS INVOLVEMENT AND COMPUTER ACTIVITY

The American Federation of Teachers has decided that the current crisis over this nation's human capital resources, along with future predictions of skill shortages, demands strong action. Last fall, the AFT Executive Council set up a blue ribbon committee, composed of one-third of its members, to examine the problem in terms of the critical area of math and science education.

One of the first items on the committee's agenda--building working relationships with the business community--stemmed from its members' view that the existence of skill shortages is a labor market issue that concerns business and education jointly. The AFT leaders also recognized that business depends heavily on the public school system to produce necessary skills. They welcome this reliance and want it to take the form of a supportive and constructive relationship.

Whether it is to strengthen the ties with the business community, to develop their own teacher and curriculum policies, or to develop legislative recommendations, the AFT leaders saw the need to have a clearer picture of what generalizations about math and science teachers and the curriculum apply to conditions in their own locals and states. While there has been much talk about the math and science teacher shortage and the lack of student exposure to these important subjects, there is little data regarding what is going on at the local level. Where it does exist, little has been done to relate one set of facts to another. For example, while some figures are available on whether or not teachers are available to fill existing slots, little has been done to look behind crude facts on an existing shortage to find the "hidden shortage" of teachers that might be suggested by the need to raise curriculum standards.

The AFT has decided to do a quick descriptive round-up on what was happening, in order to develop an information base for deliberations on such issues as: 1) changes in the skill requirements of the labor force that may necessitate special adjustments on the part of public education, including more extensive consultations with business; 2) recruitment and retention of math and science teachers; 3) certification standards for new math and science teachers, as well as for those already in teaching who may want to recertify in these fields; 4) accreditation standards for teacher colleges as they apply to the areas of math and science; 5) the possible addition of state and federal funds to assist localities in implementing a necessary emphasis on math and science education.

The report that follows is the result of the preliminary assessment of information from the jurisdictions of members of the AFT Executive Council. The following summary will cover four basic areas: The shortage itself; curriculum requirements in math and science; business-education (including union) relationships; and computer activity in the schools. The information provided here is simply that. The AFT's analysis of what these facts mean and its proposals on solving the math/science problem are contained in its report, "AFT Interim Report on Math and Science Education and the Math and Science Teacher Shortage."

THE SHORTAGE

New York State: Though individual school superintendents have told New York State United Teachers that they are suffering shortage pressures, State Education Department data do not yet reflect this. We already know that in looking at teachers in all categories, 216,869 declared positions in the state are filled by only 195,726 people. But breakdowns on math and science within this area are not yet available. An additional problem is that the state does not keep track of those certified to see whether or not they actually end up in teaching.

We do know, however, that the number of math and science certificates being issued is going down dramatically. For example, between 1975 and 1979, the number of provisional (newly issued) certificates declined by the following percentages:

Math	69%
Biology	43%
Chemistry	54%
Physics	50%
Earth Sciences	49%

Projected 1980 to 1985 losses are as follows:

Math	77%
Biology	50%
Chemistry	59%
Physics	65%
Earth Sciences	41%

We also know that the number of teacher preparation programs that are not producing graduates in these areas is increasing, as the following table illustrates:

SUBJECT	TOTAL EXISTING PROGRAMS	NON-GRADUATE PRODUCING PROGRAMS — 1975	NON-GRADUATE PRODUCING PROGRAMS — 1979
Math	77	.5	23
Biology	85	15	26
Chemistry	59	21	33
Physics	41	17	26
Earth Sciences	26	8	12

There are some people teaching in New York State who are not certified to teach specialty areas. There is a procedure which allows a teacher to get a "certificate of default" to teach out of area for one year, but these are being discouraged. A new 1981-82 policy requires that individual teachers, not school districts, apply for these and show proof that they are working towards full certification. Looking at all subjects, these special certificates went down from 3,679 in 1978-79 to 418 in 1980-81. Only 34 of these were granted for math in 1980-81. No data is available on science.

Minneapolis: The school system is barely meeting its requirements for math and science teachers. There are fewer applicants for jobs, a trend which is hardly surprising given the low number of graduates being turned out by the University of Minnesota, chief source of teachers for the system. Only one science education major graduated this past spring.

The number of graduates is declining, but curriculum standards are being raised, intensifying pressures on the system. For example, of the 20 new math teachers which the system hired in the fall, 10 were to cover vacancies and natural attrition, but 10 others were to fill slots in a new curriculum program designed for students who are below grade level in math.

Information from the state's education department reports the following data on licensure:

PEOPLE TEACHING MATHEMATICS WITHOUT PROPER LICENSURE

	1980-81	1981-82
Number of districts involved:	125	116
Number of teachers:		
Not licensed for mathematics	112	120
Whose license has expired	36	25
Licensed for substitute only	4	1
Licensed for half-time math only	24	22
TOTALS:	176	168

While hard data is not available, the union believes that teachers are being lost to private industry, usually within five years after they enter teaching; and that typically these are the better teachers.

New York City: Some teachers are teaching out of license. In the high schools, 12% of math teachers and 7% of science teachers are working out of license. In the junior high schools, the figure is about 35% in both categories. (Note: In New York City, teachers must have special licenses in addition to state certification, thus creating a somewhat higher standard.) Existing policies allow teachers to teach out of license for a limited portion of their teaching program.

Recently, the UFT and the board negotiated a Shortage License Area clause. In the 1983-84 school year, math teachers will be able to voluntarily teach an extra class at the secondary level. Safeguards are built into the agreement to prevent abuse. Shortages must be determined by the Chancellor and confirmed by the union. There must be no teacher on an unassigned list and a semi-annual offering of the exam for teachers in the subject area. The additional class is based on strict seniority and rotation among volunteers. Teachers who elect to teach the extra class will be paid an additional, non-pensionable $4500 for the year or any pro-rated portion of that amount depending on the number of classes taught. Because it is more expensive for the system to cover classes this way, an incentive to recruit additional teachers is maintained.

Declines in the pool of those being prepared to teach have raised concern about future filling of slots. For example, a recent survey of physics teachers in the city showed an average age of 50-55, indicating a potential crisis in the next few years. A recent city comptroller's report lays part of the blame on comparatively low teacher salaries relative to private industry. Average entry level salaries for graduates in math, science and engineering are $24,500, while the entry salary for teachers in the just completed school year was $11,821.

Dade County (Miami): In Dade County, Florida, the shortage takes the form of teachers teaching out of their field. No specific data is available on numbers. State reports show that districts all over Florida are having difficulty finding certified math and science teachers, and that many who are found have only minored in science or math. Since the state's college system has recently upgraded its curriculum requirements for entering freshmen, adding on year each of math and science, this will increase the pressures to find qualified people.

Chicago: While the numbers are still small (specifics not available), Chicago does report a shortage of math teachers. In science, while the availability is low, thus far, positions are covered. The situation has been this way for about three years, but it is predicted that the shortage will intensify.

Some are teaching math who have not passed the math test required, but all of these have completed the necessary course requirements. In the case of science teachers, all are fully qualified. The Chicago Teachers Union believes the shortage is generally due to teacher unease about job security (layoffs in Chicago have amounted to 2,500 over three years) and the fact that salaries are not competitive with those in private industry.

Trends in those teacher colleges which feed the Chicago system are not heartening. In the last three years, Northeast Illinois University and the University of Illinois (Chicago campus) each had only between three and ten graduates for secondary math teaching. The Chicago State University reports that with the push on computer technology, the overall number of math/science majors does not include those who go into computer sciences, since these programs are not related to math and science departments. While the education schools do not track their graduates, they roughly estimate that between one-third and one-half of them do not go into teaching.

Los Angeles: California's state report on High Technolgy and High School (June 1982) indicates that of the 170 long-term emergency math credentials issued in 1980-81 (teachers who are currently teaching out of field but have at least 10 college units in the subject), 92 were to teach in the Los Angeles Unified School District. An additional 78 limited-term licenses (no college units in the field) were issued for math teachers. During the 1981-82 school year, a total of 333 long-term and limited-term licenses were issued in math.

In 1980-81, only nine long-term and limited-term emergency credentials were issued in science; in 1981-82, 82 were issued.

Leaders of the United Teachers of Los Angeles predict that ongoing changes in the curriculum standards may bring the shortage issue to a head soon.

Gary, Indiana: There is no shortage of math and science teachers in Gary, probably for the very simple reason that unemployment is so high in the area that no one dares contemplate a job change. Enrollment is declining, which also eases recruitment pressures. Instability over teacher employment, given pressures to cut staff, are probably discouraging potentional teachers from considering teaching careers in math and science as well as other areas.

Dearborn, Michigan: While Dearborn is not now suffering a shortage, the fact of an aging staff is raising predictions of one. While all math teachers are certified, a number are not math majors, which is a fact causing some concern. For example, 50% of the junior high school math teachers are not majors, though in the high schools they still all are. One problem is retaining new teachers who may not be able to get full-time jobs initially, so they drift into business after substituting for a while. Another disincentive is caused by the layoff picture, which causes insecurity and a rising tendency for people to leave teaching or not to enter in the first place. Trends among graduates produced by the leading feeder colleges--the University of Michigan, Eastern Michigan University and Central Michigan University--are not available.

New Orleans: The New Orleans system is short in both math and science teachers, though this has been true for some time. An intensified shortage is predicted, since the number of graduates from the University of New Orleans, chief feeder college for the system's teachers, is declining. Currently, prospective teachers need to pass the National Teachers Examination. A minimum of 20 hours is required for math, and from 20 to 32 hours in science, depending on the subject.

Pittsburgh: While there is no dramatic shortage in Pittsburgh, the system has problems finding qualified substitutes when maternity and sick leave are taken. There are virtually no math and science teachers on the substitute lists. Another phenomena indicating tightness of availability is that the high schools are "cannibalizing" the middle schools of math and science teachers. As certified math teachers, many junior high teachers can teach at the high school level, whereas requirements at the junior high school level are loose enough to allow elementary teachers to teach there. The State of Pennsylvania is very tough on the question of teachers functioning out of their certification area. Penalties against a school district for allowing this amount to $6,000.

Earlier, teachers were leaving the system to take jobs in business, but this has fallen off some, perhaps, in part, due to the newer salaries offered in the Pittsburgh contract. Reports from teacher colleges indicate that this is still a problem. For example, of the six teachers certified by Duquesne University to teach math last year, two took education jobs and four went into private industry.

San Francisco: The San Francisco Federation of Teachers reports a shortage in their 3,300-member teaching force. The system is also experiencing an enrollment increase. Teachers with expertise in math and science sometimes leave the system for higher paying jobs in the Silicon Valley. A state report (See Los Angeles) indicates that in the Bay Area, of 465 science teachers surveyed, 16% stated they had not majored in science.

Massachusetts: Statewide, there have been between ten and twelve thousand layoffs, although math and science teachers have been marginally affected. Some teachers left the profession when Proposition 2½ passed to take jobs in high-tech or technical writing fields. There are teachers teaching out of their area, although there is a ceiling on the number of courses allowed to be taught out of area--40% or two classes. Some systems are moving the middle school 7th and 8th back into the elementary schools.

Detroit: The Detroit Federation of Teachers also reports some shortage, particularly in math, with a large number of teachers teaching out of their certification areas. The system's math department does authorize 90-day temporary certificates.

Some teachers have left the system, having received "better offers" from business and industry.

An overall decline in education graduates is reflected in the recent 20% cut in the University of Michigan's college of education.

Cleveland: Of the system's 3,603 teachers, 183 are in science and 187 are in math. Some elementary teachers have been moved to teach math in junior high grades 7 and 8. Cleveland has suffered massive layoffs but reports that math and science teachers were not as critically affected as other areas. The

Cleveland Teachers Union says that one factor influencing proper filling of positions is the board's inaccuracy in projecting enrollment figures. Out of the 262 teachers laid off in the Spring of 1981, 55 were recalled in June and the rest in October after classes had already begun.

Montana: Concerning the number of math and science teachers who are teaching out of certification areas, the following information from the Montana Office of Public Instruction is for 1980-81:

Science:		Mathematics:	
General Science	12	General math	16
Physics	5	Algebra	1
Earth Science	5		
Physical Science	10		
Modern Science	1		
Biology	3		
Chemistry	1		
Total:	17	Total:	17

Although Montana hasn't seen a marked increase in teachers teaching mathematics and science out of their areas right now, it projects a greater problem within the next few years.

Washington, D.C.: The system is experiencing an overall shortage, but recent layoffs did not affect math and science as much as other areas.

There are two types of temporary certification available: a standard, one-year certificate and a two-year probationary/provisional certificate for those who are within 30 hours of completing course requirements. The latter is issued with agreement to complete coursework.

Virgin Islands: A total of 1,575 teachers are in the system (islands of St. Thomas and St. Croix); seventy-eight in secondary math and 84 in science. While all are certified, some are questioning what constitutes adequate preparation, since some teachers are teaching in their minor subjects.

Philadelphia: Philadelphia is experiencing shortages for math teachers in the junior high schools. Any teacher who wants to go back to school to gain certification in math can get tuition reduced by 1/3. These teachers would actually teach math in the junior high schools while on an intern certificate obtained by taking a special test. Those who are successfully certified in math are guaranteed a teaching position. They can also use their certification to transfer into other junior high or high schools if openings occur.

Rhode Island: The Rhode Island Federation of Teachers reports no shortages and no one teaching out of certification area. However, a future shortage is anticipated and has already resulted in a proposal at the state level to offer loans for up to $2,500 to math and science graduates who enter teaching. These loans could be forgiven in return for years served in teaching.

Baltimore: The system employs about 6,800 teachers. The union says that, in the past, some teachers have left to take jobs in the private sector, producing a shortage. This school year, some teachers were hired for math and science who were not fully certified.

Yonkers, New York: A shortage exists in math but not in science. Of 1,550 teachers, 69 are in mathematics and 66 in science. In the 1981-82 school year, the system exhausted its list of available math teachers. Because there is a job security provision in the local's contract, teachers have not been laid off, but there have been no new hirings either due to the economic crisis. The majority of teachers in the system have been there between 15 and 30 years and are at the top of the salary schedule. Therefore, few are leaving to go to the area's businesses. All teachers are certified.

Will County, Illinois: Of a teaching force of 3,500, approximately 600 are in mathematics and science. This school year, the system is short between 10 to 20 teachers, particularly in science. This is not a new occurrence in Will County. The system is made up of 27 federated school districts which are relatively small in student populations. There has always been a problem recruiting science teachers. For example, a teacher who has majored in physics will typically choose to teach in a district large enough to offer several sections of physics, as opposed to a small district which may offer only one physics class and four general science classes.

The biggest problem is the upgrading of those who are minimally prepared or not fully certified. Once many obtain jobs, they do not continue a course of study in their field.

CONCLUSIONS

- At this point, the shortage in the sites surveyed does not, for the most part, take the form of slots unfilled. Rather, people may be on temporary licenses, or they may be certified but not majors, or they may be trained to be elementary or junior high school teachers but asked to teach specialties one level higher. Substitute teachers may be unavailable.
- The number of teachers in these specialties is declining dramatically. At the same time, many now teaching are older and anticipate retirement relatively soon. Virtually every response to our survey indicates a more serious impending shortage.
- Moves to upgrade curriculum standards (see next section) will intensify the shortage. Such steps are already in the works in a number of states. In addition, some universities are hiking their standards which will create pressure on school systems to upgrade curriculum requirements for precollege students.
- Data on the shortage is generally inadequate. Teacher training institutions usually do not follow up on whether or not their students end up teaching. Little is known as to who leaves teaching to enter business in math and science related fields, since school systems do not keep track of this information.

STANDARDS: CURRICULUM REQUIREMENTS AND TEACHER UPGRADING OPPORTUNITIES

In this section, discussion of curriculum standards confines itself to the question of high school graduation requirements. This is not meant to imply that elementary and junior high school curriculum standards are unimportant. Obviously, their quality is often determinant when it comes to student inclinations and success at higher levels. Their substance and quality will be addressed at future sessions of the special AFT committee.

New York State: The general high school diploma in New York State now requires one year of math and one of science, plus a three-unit sequence in any one of a number of areas, including math and science. The state's recommended precollege sequence was recently revised, as was the Regents Exam affecting mathematics. There is a general perception that materials are not keeping pace with the state of the art.

Teacher retooling programs are on a district-by-district basis at this point, though the Board of Regents has discussed the possibility of state-supported inservice programs for retraining teachers from other fields to teach science and math.

Minneapolis: The state has no mandated requirements in math or science. These are left to local school districts. Currently, the school system operates on a trimester system. Six trimesters are required for math and five for science. New requirements for science at the 9th grade level have recently been implemented, as has a new curriculum designed to help students achieving below grade level in math. Both, as has been mentioned, have necessitated the hiring of additional teachers. (Special benefits are available to teachers who want to engage in math and science retraining.)

Yonkers, New York: General graduation requirements are one year each in math and science. Recommendations for college-bound students are two to three years in each area. Electives have been cut down. Materials are not adequate since most were purchased with NSF funds in the 1960's.

New York City: New York City requires two years of science and two years of math. Both are higher than the New York State requirement. But, even with these standards, students have increasingly been choosing easier courses. For example, in 1980, of those enrolled in the Regents biology courses, only 63% completed the curriculum; 57% took the exam; and only 36% passed it. The standards for some of the courses are not being met. The Regents standard for laboratory sciences, for example, is six periods a week, but a recent report by the City Comptroller says that 57% of those classes which claim to be meeting Regents standards are meeting only five times a week.

Special programs for math and science teacher training are also proposed in the Comptroller's report. If they were carried out at all levels proposed, the total cost would amount to about $3.8 million. The City is looking to the private sector to help pick up some of this cost, especially for computers and other expensive equipment. Some teacher training courses in computers have already begun, and a summer workshop for upgrading math and science skills was attended by teachers this past summer.

The City is attempting to address some of these shortcomings already, using its widely known "Promotional Gates Program" to test students and give those failing in math, for example, some remedial help. In the 1981-82 school year, the Board of Education also introduced the use of a comprehensive set of curriculum guidelines for grades K-12. These "Minimum Teaching Essentials" bring special focus to the math and science curricula.

Dade County (Miami): Curriculum requirements are not mandated at the state level, though the state is currently developing standards of excellence in a number of areas, including math and science. Public university requirements are being upgraded to add one year each of math and science to the entrance requirements for freshmen. In Dade County, two years of math are required (more for college preparatory students) and two semesters of science. An additional year of science is expected of college-bound students.

The state has recently made a bold move in offering free tuition to teachers who want to obtain math or science certification.

Chicago: A general diploma requires three years in a combination of math and science courses. The college preparatory program requires three years of math and two years of science. Recent upgrading of the curriculum has focused only on the addition of computer sciences, though the necessary materials and equipment are not always readily available. The State of Illinois has no specific requirements in math or science.

As for teacher upgrading, the traditional inservice programs in these specialty areas are the current rule of thumb, although the Chicago Teachers Union is now engaging in discussions with a consortium of local colleges to consider additions and improvements.

Los Angeles: In California, local school boards set curriculum standards, but every board is expected to include science and mathematics among its requirements. In Los Angeles, the requirement is for two years of math and two of science. Recent upgrading of the University of California requirements will undoubtedly cause a similar upgrading in the Los Angeles schools. The United Teachers of Los Angeles fears that this will cut the number of electives offered to students.

Teacher retooling for math and science falls into the traditional inservice pattern.

Gary, Indiana: A general diploma from the Gary public schools requires two units of math and one of science. For college preparatory students, three years of math and two to three of science are necessary. The state's General Education Commission is currently studying the elevation of requirements in both areas.

In Gary, regular inservice training would be the standard form of retooling for math and science teachers.

Dearborn, Michigan: With the exception of one course in civics, the State of Michigan sets no specific requirements for curriculu. In Dearborn, all students are tracked in one of four tracks. While all students may be required to take the same number of semester courses, actual course content and material varies according to track. All students are required to take three semesters each of math and science. Progress is generally very high, with at least one-third of the students reaching advanced math, for example. Dearborn also has a set of electives in computer studies.

Teacher upgrading is done through traditional inservice programs.

New Orleans: The state requires two years of science and two years of math for high school graduation.

While there are no programs specifically designed for math and science teachers, there is a professional improvement program for teachers with at least three years of experience. Completing course work (tuition-free) over the period of the program offers additional pay for teachers.

Pittsburgh: Most requirements are left to the local school districts in Pennsylvania. Two years of science and two of math are required for graduation in Pittsburgh. The college preparatory program mandates three years of science and math. A special scholars program offers up to four or five years in each subject.

Some changes have already been made in the curriculum. Computer Sciences is one addition. It comes in the form of a math credit. Graduation requirements have recently been raised from 17 to 19 Carnegie units.*

San Francisco: Requirements are currently in a state of flux, since the board is preparing to mandate a uniform set of requirements. Presently, a general diploma requires two years of math and one year of laboratory science. College preparatory students take an additional year in each area. Electives are offered in advanced chemistry, advanced physics, advanced placement math and a math/physics combination. However, electives are being cut. Generally, materials and resources are scarce. Many science labs have 40 students and only 30 stations.

In San Francisco, teachers can take a one-year sabbatical with 60% of their pay. Since this is for one year only, there is a trend to take related course work as opposed to pursuing course work in a new field for additional certification.

Massachusetts: Curriculum is set by local boards with 16 units required for graduation. Typically, one year of general math is required for graduation. College preparatory standards are two years of math (algebra and geometry) and one year of laboratory science.

Detroit: In 1978-79, the system increased its curriculum requirements from 120 to 200 hours, primarily to reflect an increase in required "life-skill" courses. Currently, students in grades 9 and 10 are required to take one to one and one-half years of math and one year of general science. Electives are left up to the building principal. Some high schools do not offer math beyond Algebra 1. Physics and chemistry courses may not be taught in every high school.

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* Carnegie Unit: This is the amount of credit given for the successful completion of a course which meets 40 minutes daily, five days per week, for at least 36 weeks, or the equivalent amount of time within the school year. The equivalent time is 120 clock hours. (From Policies and Standards for the Approval of Secondary Schools, North Central Association.)

Cleveland: Ohio just recently raised the required number of Carnegie units from 17 to 18. Presently, one unit each in math and science is required of Cleveland public school graduates. Students graduating in 1987 will have had to earn an additional math credit.

Ninety K-6 teachers are working with the system's math office on reviewing mastery of math skills at the elementary level.

The board reports that secondary enrollment in science electives is down due to student disinterest.

Washington, D.C.: The system has recently raised the number of Carnegie units for graduation. Included in this increase is an additional unit each in math and science and a "Life Skill" seminar. The system also offers a magnet math/ science high school.

Retraining and retooling are offered through the local teacher center.

Philadelphia: Requirements for a general diploma are one year in math and one in science. College preparatory requirements are three years of math (Algebra I and II and geometry) and two years of science with at least one lab course.

Baltimore: The district requires two years of math and one year of biology.

System inservice is the typical retooling effort.

Montana: Requirements for graduation are two years of math and one year of lab science.

Virgin Islands: Requirements for graduation are two Carnegie units of math and two units of science (one biology, one physical).

CONCLUSIONS

- Curriculum upgrading in math and science is a matter for widespread concern, and moves are already being made to implement improvements in a number of places. If pressure to upgrade continues, it will obviously create a necessity for additional teachers. Thus, a "hidden shortage" is already in the making.
- Little specific seems to be underway to improve the skills for math and science teachers other than the usual inservice programs. The Florida and New Orleans free tuition plans are notable exceptions.
- Computer courses are rapidly being added to curriculum offerings. (See section on computer activity.)
- States have frequently left the determination of math and science curriculum requirements to local school boards, resulting in variable standards.

BUSINESS COOPERATION

New York State: Activities have already begun at the state level which involve cooperative work between the New York State United Teachers (NYSUT), the New York State Business Council, General Electric Company, and others. A conference, "Towards Work in New York State," was held in October 1982, and while this did not concentrate specifically on math and science, the issue of their quality was an underlying agenda item. State Commissioner of Education Ambach is already initiating discussions on legislation that would affect math and science teacher recruitment, among other things. NYSUT intends to promote the math/science shortage issue with the New York State Business Council and others.

Minneapolis: Business complains that they have to retrain new employees in writing and math skills. Some corporations have their own remedial programs (Honeywell, for example), which employs teachers from the school system.

Several business councils exist (Minnesota Business Partnership, High Tech Council), and a new coalition (Wellspring) involving business, labor, education and government is focusing on the transferring of technology into the state economy to create jobs. The area's High Tech Council is working with the Institute of Technology at the University of Minnesota. The Task Force on Economic Expansion and Training, chaired by the chief executive officer of Control Data, Corporation, is addressing the issue of public school math and science training.

New York City: A number of groups are actively moving already, including the New York City Partnership, which is identifying specific programs to be jointly sponsored by the school system, the United Federation of Teachers and business. Frank Macchiarola is leaving the Chancellor's post in the school system to chair the Partnership.

Another coalition is the Association for a Better New York, which co-sponsors the United Federation of Teachers' "Dial-A-Teacher" program. To date, New York businesses seem to concentrate not only on the lack of basic reading and math competency, but also computer education, word processing skills, etc. At this point, businesses recruit labor heavily from outside the city.

Yonkers, New York: Banking and retailing are the major business in the immediate area. The local Chamber of Commerce has done minimal work with the schools through its education committee.

Dade County (Miami): Currently, the local Chamber of Commerce has preoccupied itself with vocational education. Work would have to be done to broaden its agenda.

Chicago: An extensive "Adopt-A-School" program is underway with the blessings of the school superintendent. A relatively new business group, Chicago United, composed of the larger businesses in utility, banking and insurance fields, has taken an interest in this approach.

Los Angeles: Los Angeles, too, has an "Adopt-A-School" program through which corporations make contributions to individual schools, donate supplies, and set up special education programs. The United Teachers of Los Angeles sits on the Chamber of Commerce education committee and has plans to develop similar ties with the local Business Roundtable.

Gary, Indiana: Local industries, primarily steel and oil, are unhappy about basic skill levels of public school graduates but have done little to work with union or the school system to develop cooperative approaches to solving problems.

Dearborn, Michigan: Companies have little trouble with the skill levels of suburban students from the Dearborn school system.

New Orleans: About three years ago, the Metropolitan Area Council increased its focus on public schools and was instrumental in helping the passage of a local sales tax designed to raise funds for public education.

Some local companies are involved in a "Adopt-A-School" program, though little attention has been devoted to broad curriculum requirements or establishing remedial programs.

Pittsburgh: Businesses in Pittsburgh are generally concerned with basic skills. The Allegheny Conference for Community Development, the main business group, has an excellent relationship with the Pittsburgh Federation of Teachers. The Conference gives small grant awards for excellent teacher ideas and recently helped to finance a broad pro-public education campaign that strongly involved the union.

The Allegheny Conference also participated in the development of a desegregation plan for Pittsburgh.

With specific reference to math, the school system recently developed a plan called "Monitoring Achievement in Pittsburgh" (MAP), which encourages teachers to develop objectives in specific subject areas. Students are then tested on these specifics. The first subject to test this approach is math. The Conference has contributed funds for the teacher training part of this program.

Generally, business in Pittsburgh seems to have some special concerns about math and science skills and is interested in working with the union and the school system in improving them.

Cleveland: Steel and its related industries make up most of the business community, along with manufacturing and machining. There has not been much movement on the part of business, although several foundations have been in existence for several years. Business partnerships are primarily with individual schools, similar to adopt-a-school programs.

The state superintendent of schools has convened a state Commission on Education Excellence with 22 representatives from labor, business and education. The initial questions identified by this state task force do not address the role of business.

Montana: The governor's push for business working with state government resulted in a summer "Business Week" institute for students.

Washington, D.C.: While federal government operations is the major "industry," banking, high-tech and retailing are the major private sector businesses. Several major corporations, including GM, Xerox and Control Data are discussing providing partnerships in establishing career high schools in D.C.

San Francisco: The California Business Roundtable has met once with the president of the California Federation of Teachers to discuss joint efforts.

The San Francisco Education Fund, financed by business, offers mini-grants to teachers for program development. Recently, the Fund awarded the district a $200,000 grant to develop computer science program. "Executive on Loan" programs have also been ongoing, providing managerial assistance to the administration.

Massachusetts: Many businesses run their own schools, particularly the high-tech industries (Route 128 is the home of Digital, Honeywell, Wang, etc.). Remedial courses offered by these companies reflect a dissatisfaction with the skills of incoming employees.

Business has "offered" to work with the schools, but many of these companies belong to the High-Tech Council which was considered a prime mover for Proposition 2½.

CONCLUSIONS

- The formation of business-education groups is relatively new, but is proceeding in a number of states.
- Adopt-A-School programs seem to be the most popular form of corporate activity with the public schools, with inadequate basic skills of high school graduates as their most common complaint. This preference for a school-by-school approach might indicate a shying away from broader questions regarding curricula change, teacher recruitment, etc.
- Though the clearest emphasis is on basic skills, businesses in a number of cities give special attention to math and computer sciences.
- If business, AFT affiliates and public school systems are to take up the problem of math and science education, they will have to analyze business needs, not only in terms of entry-level jobs and basic skills but also in terms of preparation for specialized training and post-secondary education. The value of specialized high schools and curricular tracks should be considered. For this reason, it may also make sense to bring universities into collaborative discussions with business, the AFT and the schools.

COMPUTER ACTIVITY IN THE SCHOOLS

New York City: The report of the Comptroller of the City of New York bemoans the lack of computer equipment and teacher training in computer use. At the secondary level, there is some activity in almost all schools. In some schools, students learn programming to provide help in school management tasks such as attendance.

The New York City Teacher Centers Consortium is training all of its staff in computers under a grant with Queens College. The NYCTCC has also developed a resource booklet on microcomputers as part of their "Centering On" publications. The spring listing of graduate and inservice courses provides 12 sections of computer courses for elementary, secondary and special education teachers ranging from literacy, to programming, to CAI (computer assisted instruction). Sessions have been filled, with many teachers on "waiting lists." There is also a joint UFT-Board proposal which has been endorsed by the New York City Partnership to do a comprehensive assessment of the system's computer education needs and to develop a program in the area which will avoid errors and waste.

California: Former Governor Jerry Brown established 19 regional tech centers for assisting school districts in planning and inservice. Los Angeles reports nothing in computer courses for students and no commitment to do so. In San Francisco, an Education Fund grant will focus on computers in schools. Chapter I schools use CAI, and there are a few high school demonstration centers. The union's Educational Issues Committee has provided inservice for teachers.

There is a statewide educational computer users' network, but "membership" seems to be users from more wealthy districts.

The Atari Foundation has funded a Silicon Valley district program whereby students and parents can retrieve school records and information on high school and college programs on home computers!

Massachusetts: Computer usage is increasing. Due to the influence of Route 128, schools offer a variety of computer-related courses: CAI, programming, keypunch in secondary commercial departments and hardward repair in vocational programs. The governor has publicly declared he wants all students to be computer literate.

New Orleans: Not all schools have computers. But some students in elementary, junior and senior high schools have access to CAI in various classes. Usually, these are purchased with an individual building's discretionary funds.

Detroit: Other programs were cut to finance computer use in reading management (maintaining diagnostic, prescriptive and progress data on students). Training was sloppy because administrators were minimally trained, then trained teachers.

Minnesota: There is a new rush to computer literacy. The newly elected governor, Rudy Perpich, in his inaugural address said he wants schools to strengthen programs in foreign languages, computers and science. Minneapolis is in the first year of its 5-Year Plan which emphasizes computers (including funding) in classrooms. Courses in programming are part of the proposed new curriculum.

All school districts are mandated to join the Minnesota Educational Computing Consortium (MECC), although Minneapolis is presently trying to "disaffiliate." Membership is costing them $400,000 annually, and they have had to rewrite many programs to make them compatible with the Consortium's.

Elementary teachers are flocking to computer literacy courses.

Legislatively, there is a bill proposed requiring computer literacy for all teachers, but the Minnesota Federation of Teachers fears cuts in regular education programs may result in order to fund this proposal.

Cleveland: The district is moving rather cautiously. In the Fall of 1983, three targeted schools (one elementary, one junior high and one senior high) will be piloting a program. Each will house 16 micros for student use. The system will also provide summer training for teachers and is pursuing graduate credit for training.

Pittsburgh: Of the system's 11 high schools, 10 offer two years of computer courses and one offers four years. Approximately 1,000 students are enrolled in these courses. Computer literacy is offered using TRS-80 micros, as is programming. FORTRAN is taught in advanced courses by tying into the system's mainframe central processing unit (CPU).

Certification for teachers can be either a separate license in data processing or an instructional certificate in math or science with an endorsement of two courses in computer science. The teacher center is designing comprehensive courses for teachers to begin in September 1983.

Gary, Indiana: Computers have been in high school use for the past three or four years and are being placed in elementary schools. There is talk of possibly making a computer course requirement for 10th grade. The system currently provides inservice for teachers.

Montana: A survey by the Office of Public Instruction done in the 1981-82 school year reports these findings on computer usage (540 schools surveyed, 387 responding): 614 teachers in 210 schools were utilizing 582 microcomputers. An additional 168 schools were planning purchases. While all grade levels and subject areas reported usage, a concentration was found in math, computer education and programming classes at the high school level. An updated 1982-83 survey reports 1,689 teachers using 1,670 computers in 499 schools.

Washington, D.C.: Computer courses are offered at the math/science high school. The teacher center offers courses which are filled to capacity.

Virgin Islands: The Islands just began courses for students, providing inservice for teachers. APPLE computers have been placed in five secondary and seven elementary schools. A total of 161 students are enrolled in courses offered at all three high schools.

Philadelphia: There is a push by the system to put computers in every school. Courses are offered through skill centers. The State of Pennsylvania also offers mini-grants to teachers for developing courses. The new state commissioner is also promoting computer literacy.

Rhode Island: Wealther districts have computers. The state's committee on economic development is promoting computers and has recommended $8 million for the purchase of hardware and materials.

Baltimore: The city district has been using the PLATO system developed by Control Data Corporation to help provide instruction in two high schools.

Dearborn: Students have access to computers in business, math and science courses. Electives are offered in programming in BASIC, FORTRAN and COBOL. Inservice is provided for teachers.

New York State: The state department of education has begun a leadership/ clearinghouse commission on computers. Results of surveys are expected in March. The Statewide Instructional Computing Network (SICN) reports about 7,000 microcomputers in use. The 551 districts responding (out of 726 surveyed) indicated that 350,000 students and 18,000 teachers had access to micros with projected increases to 400,000 and 20,000 respectively, next year. The chairman of SICN claims a legislative proposal providing $5 million would not be enough to cover needed services, including inservice, for a comprehensive statewide plan.

Additionally, there is some discussion of creating a separate certification area for teaching computer courses. NYSUT is supporting ancillary certification, that is, endorsement for anyone already holding a teaching certificate who picks up extra course work.

Lewiston, New York: The district is offering a four-day seminar in computer literacy. Participants will receive two hours of inservice credit or 3 graduate hours. Training is free except for the payment of college graduate fees.

Chicago: In Chicago high schools, there are computer courses available taught by math teachers with endorsement of course work in computer science. At the elementary level, computer assisted instruction (CAI) is used in Chapter I programs.

A state board task force has reported that the number of districts using computers has tripled over the past few years and growth is expected to continue. The task force is also dealing with problems of training personnel and lack of appropriate quality software by establishing the capacity for consortia of districts with technical assistance personnel and central software libraries.

CONCLUSIONS

* New offerings of computer-related courses for students may put an additional drain on the math and science teacher pool since, typically, these teachers volunteer or are recruited to teach such courses.
* Steps should be taken to insure that computer courses do not replace math and science requirements, particularly in advanced subjects.
* There is a need to further investigate appropriate teacher training and certification requirements for the areas in which computers are used in schools: computer literacy, programming instruction and CAI.
* Equity needs to be established and maintained to insure access by all students to computer activity regardless of grade level, school size or wealth of the district.

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Senator **Stafford**. Thank you very much, Mr. Shanker. And now it is the committee's privilege to hear Dr. Graham.

Ms. **Graham**. Thank you very much, Mr. Chairman. I am Patricia Albjerg Graham, dean of the graduate school of education at Harvard University, and a member of the National Science Board on Precollegiate Education in Mathematics, Science, and Technology.

I want to thank you for the opportunity to appear today on behalf of the American Educational Research Association. I am presenting AERA's views on the legislation before this committee and the critical need for educational research authorities to be included in any new legislation designed to improve instruction in mathematics, the sciences, and technology.

I want the committee to know that we at the American Educational Research Association join in the statement presented on behalf of the higher education community, and I would like to submit that for the record.

[The material referred to follows:]

AMERICAN EDUCATIONAL RESEARCH ASSOCIATION

Statement Presented To The

UNITED STATES SENATE

COMMITTEE ON LABOR AND HUMAN RESOURCES
SUBCOMMITTEE ON EDUCATION, ARTS, AND HUMANITIES

THE HONORABLE ROBERT STAFFORD, CHAIRMAN

Mr. Chairman, I am Patricia Albjerg Graham, Dean of the Harvard Graduate School of Education and a member of the National Science Board Commission on Precollege Education in Mathematics, Science, & Technology. I want to thank you for the opportunity to appear today on behalf of the American Educational Research Association. I am presenting AERA's views on the legislation before this Committee and the critical need for educational research authorities to be included in any new legislation designed to improve instruction in mathematics, the sciences, and technology. We want the Committee to know that we join in the statement presented on behalf of the higher education community.

I appear here today to request that the Committee provide specifically for educational research and development authorities in new legislation to improve mathematics, science, and technical education. Such authority will improve the quality of other efforts sponsored by legislation and will restore educational inquiry competitions and authorities lost or damaged by budget reconciliation and appropriations decisions in recent years.

I believe that both the National Institute of Education and the National Science Foundation science education unit should have complementary authorities to support educational research and program and instructional development activities. These efforts would draw upon the strengths of both agencies.

The strength of the National Institute of Education is in its associations with education policy makers and practicing educators in schools and colleges. The Institute also has the capacity to support the critical merger of teaching and learning research with the substantive subject areas of mathematics, science, and technology. NIE would support teaching and learning research, the application of instructional research to teacher training and instructional materials development, analysis of state and local policies (as they affect the recruitment and retention of effective teachers), and the study of school operations and organization as it affects math and science instruction. NIE also conducts studies of advanced academic skills needed for further learning and work. This authority would expedite the application of research on literacy skills to math and science instruction.

The National Science Foundation has strong ties to practicing scientists and engineers. The Foundation is in a strong position to (a) support research and substantive program development activities; (b) merge the basic and applied cognitive, engineering, and information/computer sciences with instructional strategies; and (c) work to improve undergraduate and other adult learning in the areas of math, science, and technology.

The legislation should encourage mutual consultation between NIE and NSF, and promote cooperation on the development of R&D agendas, the selection of peer reviewers, and the dissemination of R&D results. Here, also, the diverse strength of each agency can be combined to improve the use of funded inquiry. NIE works directly with teachers, administrators, state school officials, and other practicing school and teacher educators. NSF, in addition to the ties with the scientific community, has an established record of working with the press and electronic media, and with the private sector.

These recommendations are designed to improve the focus of the legislation and provide assurances that the quality of projects supported will be addressed. As noted below, the problems are complex and diverse and the solutions must be focused and effective. We need to improve the capacities of educational institutions to deliver effective education to school and college students.

RATIONALE

There is little need to reiterate the studies and research which have defined and clarified the various issues and problems associated with learning in math and science. The National Institute of Education, the National Science Foundation and the National Science Board's Commission on Precollege Education in Mathematics, Science, and Technology, the National Academy of Sciences, the Office of Technology Assessment, and Congressional Research Service have identified the central issue and priority education problems associated with math, science, and technical literacy. Briefly stated:

> The intellectual demands of the workplace and advanced education require much broader student participation and success in mathematics, the sciences, and the higher order academic skills -- reading comprehension, problem solving, written composition, creative and analytical thinking, and technological literacy.

Yet, as Michael Kirst recently summarized:

> "...we find ourselves in a vicious cycle of teacher shortages, outmoded curricula, and unmotivated students." ("Improving Math, Science and Technical Education" California Commission on Industrial Innovation, July 1982)

The resarch and testimony focus on the following priority problems:

1. Out-of-field and out-of-date teaching force. Many teachers are in math and science classrooms, particularly in secondary schools, who are not prepared to teach the courses they are assigned. They serve with "emergency certificates" or have little recent information on math, science, technology, and instructional advances.

2. Severe shortages of qualified math and science teachers due to an inability to attract new teachers to the classrooms or to the inability to keep able and effective teachers.

3. The need to assure that students have mastered the basic and advanced academic skills needed for further learning. Such skills include reading comprehension, math problem solving, creative and analytical thinking, written composition, and technological literacy.

4. The need for more effective and motivating teaching resource materials and teacher training resources so that we can reach a larger number of students. Due to dramatic cuts in educational research and development, dissemination and technical assistance, the capacity to improve student motivation and learning and to adequately prepare and update teachers in mathematics and science has declined.

5. The need for greater access and more effective use of instructional technologies. The micro-computer and other information technologies are unevenly distributed in education institutions, they are under-used for instructional purposes, and the software materials are not adequately developed with an understanding of the latest research on student learning and instruction.

With few exceptions, research and the reports on the problems and issues call for a sustained program of educational research as an essential resource for other federal, state, local and institutional programs to improve mathematics, science and technical education. The following educational research efforts should be seen as priorities in new math and science education legislation--

(a) research on thinking, teaching, and learning related to instruction in math, science and technology, including reasons for learning difficulties and the instructional uses of information technologies;

(b) the application of research findings to the development of instructional resource materials and teacher training programs;

(c) research on the effects of secondary school organization and instructional strategies on student learning in math, science and technology;

(d) research on student achievement in higher order academic skills -- reading comprehension, written composition, problem solving and creative, analytical thinking, including computer and technological literacy-- which are essential for work and further learning;

(e) analysis of local and institutional policies enhancing or inhibiting the recruitment, retention, and upgrading of mathematics and science faculties.

When supporting projects in these areas, some attention should be paid to analyses of math and science instruction and materials in other nations. Studies must also increase our understanding with regard to access and success in math and science among underrepresented groups. For each of the priority problem areas outlined above, new research projects and efforts to use current findings of educational research will provide knowledge and informational resources that are needed for educational improvement. As will be outlined below, these studies will contribute to both short-term efforts to ease immediate problems and long-term fundamental solutions.

The Uses of Research Findings

Educational research has made important progress in identifying successful teaching practices, effective school characteristics, and student learning. Although the majority of these studies have been focused on elementary schools, progress has been made recently which will contribute instruction at the secondary and postsecondary education levels.

There is significant need for further work in these areas; however, not all of what is known is effectively incorporated into instructional materials and teaching practices. For example, recent research on how learners approach math and science problems is ripe for development into improved diagnosis and instruction.

The Promise of Emerging Research Findings & New Research Programs

Fortunately, past and current research efforts are, although poorly funded, on the right track. They allow us to build new research on past knowledge, to ask the right questions and, most importantly, to provide practical and useful information to those in the front lines of education --the teachers, administrators, and education policy makers.

The focus of research studies on mathematics and science instruction will help us blend the need to learn substantive knowledge with effective instructional strategies. In past efforts, either too much emphasis was placed on providing teachers with new mathematics and science information —to the neglect of realistic ways to assist students in real classroom situations— or too much focus was placed on teaching process concerns —to the neglect of important substantive curricular needs. Recent improvements in research will allow the research authorized in new legislation to promote an appropriate mix of process and substance and their application to:

—instructional materials

—teacher training programs

—school-site instructional improvement

—secondary school math and science programs

—advances in technological literacy and the appropriate and effective instructional uses of information technologies.

These research and instructional improvement efforts need to be initiated NOW. The outmoded instruction and curricular materials and strategies demand upgrading. Our methods of teaching mathematics and science, successful for a small number of students pursuing academic careers in these areas, are not adequate for the much broader student population needing these academic skills. The demands of work and essential academic skills, what employers call "learning to learn" skills, require that we provide teachers with the best available knowledge and material resources.

In summary, I would like to outline the priority problem areas and indicate potential solution categories and the contributions of current or potential research findings.

Summary of Math and Science Education Problem Areas

(Possible solution categories and research and development contributions)

Note: These possible solutions have been identified from proposed legislation, state and local efforts, and from testimony. They are not specific recommendations by AERA.

OUT-OF-DATE AND/OR OUT-OF-FIELD (UNQUALIFIED) MATH AND SCIENCE TEACHERS

Most immediate solution categories:

—individual continuing education for teachers already in service (substantive knowledge in subject areas and recent developments in teaching strategies);
—staff development at the school site (working to make the school and classroom effective places to teach and learn).

R&D Contributions

Immediate contributions of effective teaching and school research findings to teacher training programs are needed to mount inservice education programs and staff development efforts. Particular fields for research application include: math and science classroom management and instructional strategies, student thinking and learning, and initial identification of effective secondary school characteristics.

OUT-OF-DATE OR INEFFECTIVE TEACHING RESOURCES (materials/strategies) & TEACHER TRAINING PROGRAMS (for new teachers and those already teaching)

Solution categories:

—the improvement of teacher training and staff development programs (using available information on mathematics, science, and instruction/learning strategies);
—the development of curricular materials, including computer software;
--developing reward systems which bring together teachers and teaching resource organizations.

R&D Contributions

--the application of teaching and learning research to the development of texts, instructional software, and teacher-developed instructional programs.
—new R&D into student motivation, thinking and learning, and applied research on classroom teaching in mathematics, the sciences, and technical literacy.
—reasons for learning difficulties in M&S.
--the identification of essential academic skills needed for successful work and future learning (including on-the-job training).

THE LACK OF QUALIFIED TEACHERS ENTERING THE PROFESSION, AND THE LOSS OF CURRENT TEACHERS TO OTHER OCCUPATIONS.

Solution categories:
—teacher education incentives and support;
--status improvement of the existing teaching force;
—using qualified teachers in staff development efforts;
—providing financial rewards for entering and staying in math and science teaching.

R&D contributions
—analysis of local and institutional policies as they affect the recruitment, retention and professional advancement of teachers.
--comparative studies and dissemination of effective strategies for coping with the problems.
—collaborative research using qualified researchers as teacher-researcher partners with principal investigators on math and science education research projects.

LACK OF ACCESS AND EFFECTIVE INSTRUCTIONAL USE OF COMPUTERS AND OTHER INFORMATION TECHNOLOGIES

Solution categories:
—provide funds for the acquisition of micro-computers and other technologies
—provide incentives for corporations to provide schools with low cost or no cost equipment;
—provide support and incentives for educators and publishers/software developers to work together on the development of improved resource materials;
—provide support and incentives for schools to work with private and public sector math and science resources —museums, libraries, scientific laboratories, the media, and so on.

R&D Contributions
—the application of teaching and learning research to the development of texts and software.
—R&D into the effective uses of computers and instructional technologies in realistic classroom settings (for computer literacy and for instruction in mathematics and science).

--research to develop criteria for school boards, teachers, and administrators to assess the value of various types of instructional hardware and software.
--research on the effects of new technologies (both in and outside of schools) on student achievement in academic subjects.

I thank you for this opportunity to present the views of the research community. I will be pleased to answer any questions. The American Educational Research Association is most willing to work with the Committee to provide information resources which you request.

Ms. GRAHAM. In the moments that remain to me, I would like to congratulate members of this committee on recognizing a vital problem in our midst, namely the fact that children, particularly upper elementary and high school students, lack mastery of mathematics and science and technology.

I think we need to recognize that this lack of mastery of mathematics and science is the tip of an iceberg. The children's inadequacy in this area represents the tip of an iceberg. And like an iceberg, that which is visible is frightening and cause for alarm. But also like an iceberg, that which is below the surface and not currently seen has even more potentially devastating consequences.

The fundamental issue, I think, that we face is the need for our society to improve and to be productive. All American youth must master the complex skills, not just the basics. We have some evidence that youngsters are not doing so badly in the basics, but the complex skills: being able to read a paragraph and understand when you have read it, what you can infer from having read it; being able to write systematically; being able to think clearly; being able to develop a perspective on our past and on our present social and economic circumstances; being able to read and speak a foreign language.

These are just as important as mathematics, science, technology, and computers. But, like the rest of the iceberg, they are generally hidden from view. Why is this a problem? It seems to me, first of all, that the basic skills which are associated with the primary grades are in reasonably good shape. The evidence from the National Assessment of Educational Progress, which is currently supported by the National Institute of Education, shows that gains for 9-year-old children across the board have been pretty good; for 13-year-olds they look less good. For 17-year-olds they look much less good. But the 9-year-olds are looking not so badly.

The question is: why is this? Although we can speculate as to what all the causes are, there are three elements which I think we have to admit have played a significant role in this achievement. The first of these is title I of the Elementary and Secondary Education Act of 1965; second is the Head Start program; and third is the research which underlay instruction for preschool children and for elementary schoolchildren, much of which was funded by the National Institute of Education, the Office of Education, the National Science Foundation.

These Federal efforts since the mid-1960's have concentrated both programmatic funds and research funds at the primary and elementary levels, and there substantial progress is now evident.

At the upper elementary, at the high school levels, achievement is a very different matter. We have substantial evidence, which I am sure that all of us here can cite, of inadequate academic performance.

Also at the upper elementary, and particularly at the high school level, practically none of the old title I money was spent, although it was authorized, but title I was never fully funded.

Until the late 1970's, the National Institute of Education had focused the research it supported at the elementary level, not at the high school level. In recent years it has been focusing, when it had money to focus, on the high school level.

The problems at the high school levels are very serious. They seem to me to include restoring academic and cognitive learning to a position of prominence for all American children; helping teachers to be much more effective in teaching in these areas; understanding the ways in which children learn and the ways in which teachers teach effectively. These are issues for research. Therefore, as we look at ways to think about solving these problems, first we must support school leaders, whoever those school leaders may be, whether they be principals, whether they be teachers, whether they be coalitions of community leaders, to address the learning issues in the school.

Second, we must look to improve teacher effectiveness through summer institutes, through programs at the school, through programs outside the schools and colleges.

And third, we must support research aimed at understanding and improving the teaching of the complex skills: cognitive research; pedagogical effectiveness; curriculum studies.

Finally, in conclusion, let me say that I have two caveats that I would like to raise about the math-science initiatives. Justice was referred to earlier. I would like to refer to it again. Traditionally, in this society the people who have done well in mathematics and science are that minority of the population who are white and male.

I recognize the importance of that segment of the population, but I recognize also the importance of the rest of the population; if we concentrate our efforts on math-science, we must include all the population, not just a portion of it.

Second, as we move to take computers seriously and make the new technologies available to children, we need to make sure that all children have access to those new technologies. If they are important learning tools for some, then they are important for all. Those children who have the new technologies at home must not be given a superior advantage over those children whose families cannot have the new technologies at home and thereby further widen the gap between the children of the rich and the children of the poor. Our society cannot afford to have that gap exist. All children must achieve satisfactorily in school levels. Thank you very much.

Senator STAFFORD. Thank you very much, Dr. Graham.

One of the principal issues facing us in the area of mathematics and science education is that of teacher retention. We have heard of low salaries relative to industry, poor teaching environments, dilapidated teaching facilities and equipment as some of the key factors in teacher dropout.

How do we realistically in the short term face the problem of teacher retention, particularly in the area of math and science? What is the Federal Government's role in this regard?

I raised this with the Secretary, but I would like to raise it again for brief comments from this panel.

Mr. McGUIRE. I would be happy to respond to that. It certainly is a difficult problem, and at the base of it, of course, the financial matters are of great importance. Teachers' salaries have lagged substantially and we are going to have to deal very carefully with that. And any influx of money that will help in the salary area will be of some help, but will not be sufficient to turn it around completely. We also talk about the feeling of rejection, the feelings around the workplace, and I believe that the American Defense Education Act addresses this at least in one regard: the involvement of the teachers, of the administration, of business and labor, the community at large, will be at least one step in the direction of moving teaching back into the area of strong community support and a high level of appreciation which once we were there, but now have diminished and has had quite a telling effect.

So my testimony, I think, addressed at least the finances in terms of substantial resources being put in the district and the involvement of the community in the building of that support which I think are critical.

Senator STAFFORD. Thank you very much.

Dr. Graham.

Ms. GRAHAM. I would simply like to observe that while I agree that it is always better to improve teachers' salaries, as Mr. McGuire suggests, that in two recent studies by the NEA in terms of what teachers considered the most important issues facing them, the first three all had to do with conditions of work and lack of public respect for the efforts that teachers were making to instruct the young.

And, therefore, I think those issues are vital to be addressed, and I think particularly the kinds of summer institutes that used to be associated with the National Science Foundation and associated with the National Endowment for the Humanities are particularly helpful in preserving teachers' sense of viability and confidence in their work.

Senator STAFFORD. Thank you.

Mr. Shanker.

Mr. SHANKER. Yes. I think that certainly in attracting new teachers the salary question is a top question because if you are going to—my experience has been that college graduates, not necessarily at the top of their class or in math or science, may take 5 or 6 months now to find a job, but when they do find one, there are training positions open where you start at $18,000 a year.

If you have had some experience with computers and have a background in math and science, $21,000 or $22,000 is not considered a windfall type of job. It is a normal entry salary.

And when you think of beginning teacher salaries, $10,000, $11,000, $13,000, even if you were to add a bonus, which would not do the job because I do not hear anybody talking about bonuses of $10,000 or $15,000. You would still have a problem competing with the private sector. I do not hear anyone talking about something which would equal or compete with what industry is doing. They are talking about $1,000 or $2,000 which is great public relations to show that you are making an effort, but the new entrant is still going to look at the $13,000 in a school system as against $23,000 in industry. Now, as far as teachers in, the retention question, I would agree with Dr. Graham that the most important issue there really are the working conditions, whether the teacher feels that he or she is accomplishing some type of life mission.

Now, some of that has to do with conditions that we talked about. Let me mention one that has not been talked about.

Our schools no longer require students to take very much math or science. If you are a math or a science teacher and if you are able, you really did not enter teaching to teach remedial arithmetic in high school to somebody who did not make it in third grade.

You may be willing to do that for one or two periods a day, but in addition to that, for your—in terms of your own interests, just as the English teacher probably wants a course in which Shakespeare or something can be taught and not just some remedial work, that teacher would like a chance teaching some advanced courses.

There are not very many advanced courses if you do not require students to take courses. All you have then is some sort of a remedial or a beginning course, and that is the beginning or end of it, and there is very little stimulation. A person interested in math or science says, look, I am wasting my time. It is nice that this kid is going to learn how to count his change when he leaves the store, but that is not why I went to school that many years.

Now, I think that one of the things that we have got to do is—and, by the way, this is a key to providing future math and science teachers—we have got to get away from the philosophy that the curriculum is made up of what children enjoy at the particular moment that they are in school or what they think is relevant, to use the phrase that has been determining our curriculum in recent years, and to reassert the notion that sometimes adults know what children need a little more than the children themselves know, and that at some later point they will find out that what we compelled them to do was right for them.

They might even enjoy it later on. But I think that one of the key features in retaining teachers is to give them a program that they enjoy teaching. And they will only get that program and we will only get our future supply of math teachers if we decide that we are going back to a period where there are requirements of an extensive period of education in these areas.

Senator **Stafford**. Thank you very much, Mr. Shanker. I think I have consumed 5 minutes. So, Senator Kennedy, I will yield to you.

Senator **Kennedy**. As the members of this panel know, we have a number of proposals before this committee at this time on this subject matter. Each of you have covered different phases of the legislation, but if you were to try and identify the three or four top priorities, what might they be?

Mr. Shanker, do you want to start off?

Mr. **Shanker**. Sure. I would state three of them: first would be retraining because that is the best way to get some quick results, even though they are not the long-term results we want, and retaining is under two categories. First, we have got to do something in terms of addressing the current deficits in these areas in the elementary schools; creating summer institutes and facilities where elementary schoolteachers who feel that they themselves are not able to do an adequate job in these areas are able to get the retraining or training or help that they need so that they can start doing an effective job with their own students.

Second, half of that retraining, probably the biggest group of math teachers we could get right away is to turn to teachers who are now teaching other subjects in secondary schools or perhaps some in elementary schools, people who majored in English or social studies or other fields, but had a minor in college in mathematics or in science, and maybe they are not too many credits away, and to say, look, we have the tuition money for you. We have a stipend over the summer so you do not have to coach or take some job over the summer.

The largest number of teachers we are likely to get in math and science in the short run are people who are already teaching other subjects and who are encouraged to move over. So, retraining is the first.

Second is recruiting, and there I think the targeting in terms of loans and scholarships for students who are willing to commit themselves to go into this is the best bet in terms of a short-term bet.

The third has to do with the emphasis on requirements because that is the long term. If we do not go to a situation where all of our high school students nationally are taking a full program throughout their school career of mathematics and science, if we are allowing children to decide in advance, this is too difficult for me; there is too much homework in it; it is easier to take some soft elective, and so I am not going to take this; what we are doing is we are now, by not enforcing curriculum standards in high schools, automatically creating a shortage which no number of incentives will undo.

Nobody is going to start on a career in mathematics and science in college if they have not gotten the foundation before that.

Mr. McGuire. I think we need as a basis either ADEA or something very similar to that that is broad and comprehensive, that works with the planning and the implementation and the evaluation of what is actually going on within the school district, from elementary school through high school.

Additionally, the inservice training, the institute program or other things within the district, I can speak very directly to that because when NDEA was passed about 25 years ago, I am a product of two of those institutes: one in foreign language under NDEA and the other sponsored by the National Science Foundation through NDEA in mathematics. And I found those, after teaching about 10 years prior to that, to be extremely helpful in the classroom. And we need to, of course, also address the preservice training to have that be effective and also be in a setting in which it will help attract our college graduates and teacher education into these areas.

Ms. Graham. I would have a slightly different set of priorities. First I would argue that, in talking about Federal legislation, the Federal Government has a responsibility for educational research that it does not have for the administration of educational programs. And, therefore, I would encourage any legislation to include serious amounts of money for research on learning, children's learning styles, on pedagogical effectiveness, on school organization, and on curriculum.

Second, I would agree with my colleagues that a high priority should be placed on various kinds of inservice training for teachers who are presently responsible for instruction in mathematics or science, either at the high school level or those who have responsibility at the elementary level as well.

I think the people who are presently there who are teaching are likely to be there for a long time, and it is imperative that those people be knowledgeable about mathematics and science and furthermore that they feel comfortable in teaching it. I fear that that is not universally the case.

Finally, I would talk about the need for support to get people to enter mathematics and science teaching at the elementary and the high school level. I am not, from my perspective, enormously optimistic about being able to get 21-year-old persons who are well trained in mathematics or science to commit themselves to a lifetime of teaching mathematics or science at the elementary or secondary level.

I hope that there will continue to be such gifted people in mathematics and science who will do that. On the other hand, I think realistically we need to start looking at some other possible pools of mathematics and science teachers, particularly people who already know about mathematics and science, but who for one reason or another may feel at the age of 50 that they might like to leave their current employer. Further, their company may feel with them that their service in the company is no longer as valuable as it once was. Some might be attracted to a 1-year program in which they might be prepared to become mathematics and science teachers, with the pension as a supplement to the salary which they would ordinarily be getting as beginning teachers at the master's level.

I think some innovative approaches of that sort bear investigation.

Senator **KENNEDY**. Mr. Chairman, my time is up. Could I ask just one additional question and then maybe submit some others for the record?

Senator **STAFFORD**. Sure.

Senator **KENNEDY**. All of you have expressed concern about the elitism which might develop from a focused program for math and science education at a precollege level. Do you all believe that the program ought to be something which is focused on the general student population rather than on the precollege student?

Mr. **SHANKER**. Yes, I certainly do. And I do not think we are going to solve the shortage problem given the demographics of this next period, that we have a decline of, oh, 20 to 22 percent in the cohorts entering both the work force and the colleges and universities, 16 to 25 year olds. If we do not reach out to groups that have not previously made it in these fields, we are not going to make it because we are just dealing with a much smaller population.

And if we do not reach minorities and women who have not previously gone into math and science in any decent proportion, if we do not reach out and recruit from these groups, then we are engaged in a hopeless enterprise because of the demographics.

Ms. **GRAHAM**. I believe the talent is widely distributed in this society, and society needs to nurture all the talent it can find. We need to look for all. The talent in the society, not just some of it as we have in the past.

Mr. **MCGUIRE**. I would agree with the two other speakers.

Senator **Kennedy**. I thank the panel for their testimony; if I could just submit a few other questions.

Thank you.

Senator **Stafford**. Thank you, Senator Kennedy. The Chair, for the members of the subcommittee, would reserve the right to all members to submit questions in writing, if that is agreeable to the panel, for response at your early convenience.

Senator Pell, do you have any questions?

Senator **Pell**. I have a couple of questions and look forward to perusing the testimony. I understand it is excellent. But I was interested in the reaction of the panel as to whether they believe that language instruction should be included as a high priority in the legislation we are considering.

And there are two kinds of language instruction I am thinking of. One is foreign language, and the other is the point that Senator Denton brought up, whether English should be included in this bill.

What would be the reaction, just going from left to right? Mr. McGuire?

Mr. **McGuire**. Thank you, Senator. I mentioned both of those and feel very strongly that they are important. We have talked about the needs at the elementary school to have a strong base in English, in reading and writing in order to be able to move ahead and do well.

Senator **Pell**. Excuse me. My question is: Should they be included in this bill?

Mr. **McGuire**. Yes, I believe they should be included in the bill.

Senator **Pell**. Both?

Mr. **McGuire**. Yes, both. And in terms of the American Defense Education Act, we are talking in terms of both.

Senator **Pell**. Right. Because this would mean less money in math and science.

Mr. **McGuire**. It might, but in terms of the American Defense Education Act, we are talking about a community response to the improvement of math and science instruction and of foreign languages. We are talking about a community based, comprehensive plan that will be implemented from elementary grades through high school in ways that the community determines best what will help the math instruction, the science instruction, and the foreign language instruction, and I believe that is going to take a strong English component as well, in reading and writing at the elementary school level in order to provide the base where those things can happen.

Senator **Pell**. Thank you.

Dr. Graham, do you think both should be in the bill?

Ms. **Graham**. Absolutely.

Senator **Pell**. Or should we just focus the approach on math and science as we do now?

Mr. **McGuire**. I think it has to be broader than just math and science.

Ms. **Graham**. My sense, Senator, is that the U.S. Senate is responsible for improving the entire Nation, and the entire Nation needs improvement in its ability to use language as well as its ability to deal with mathematic and scientific and technical matters.

Senator **Pell**. Would you include both, foreign language instruction and English language instruction?

Ms. **Graham**. Yes, I believe the Senate needs to be concerned about our priority instruction in math, but whether they are included in this bill or in separate bills I leave to the Senate.

Senator **Pell**. Thank you.

Mr. Shanker, what would be your view?

Mr. **Shanker**. It think it is a question of tactics and not a question of goals. I think there is no one here who is opposed to improvements in instruction and solving problems that we have in all these areas. But we also know that from time to time the people of this country focus on a particular issue, sometimes separating it from other important issues.

I think this is such a moment. And while I would strongly favor legislation which would generally increase education, which would increase it in categories which we have had in the past, which would focus on foreign languages—and there have been such proposals and we have supported them in the past—I think that focusing on math and science in this case is likely to produce a better program, and it is likely to produce more funds, and I think that from a tactical point of view, we are probably better off at this point not abandoning these areas, but saying that this is our mission today, and then we will go on to these other missions in the very near future.

Senator **Pell**. Thank you.

One other question, if you will permit me, Mr. Chairman, and that is, I was reading a rather dismal article in U.S. News & World Report last night about teaching. What can be done, in your view, to improve the quality of teaching? Should there be tests for teachers, or should it increase the national incentives as we are doing, but what can be done to enhance the quality of the teaching?

Mr. **Shanker**. Well, certainly, one of the things that ought to be done is that there ought to be a test for those who enter. The test will not guarantee that you—that anyone who passes those tests and even anyone who passes them with high marks, they will not necessarily make great teachers. They may have great psychological problems. They may hate children.

They may be unfit for many reasons. But I do not care how fit a person is on the basis of motivation, on the basis of his own psychology, if a person is illiterate, that person should not be a teacher. If a person does not know any mathematics, they should not be a math teacher. And if they do not know enough math to be an elementary schoolteacher, they should not be an elementary schoolteacher.

Now, some States are starting to give these minimal competency tests to teachers, and you see that there are rates of failure on simple arithmetic questions as high as—ranging from 10 percent to 70 percent failure rates.

And I would guess that if you get a failure rate of, let us say, 30 percent in a State that is giving an examination, probably the applicants know they cannot pass it; many of them have not even bothered to apply. I would say States that do not give an examination may very well be hiring from a pool where the percentages are even higher.

That is an absolute minimum that we ought to do.

Senator **Pell**. And do you think such competency checkups, the tests should be given every 10 years or 5 years, or one test?

Mr. **Shanker**. Well, I doubt very much that somebody who knew his arithmetic or her arithmetic 10 years ago and has been teaching it for 10 years has forgotten it after 10. I also do not think that it is a very good recruiting device to tell new people, come on in, we are hiring you for 5 or 10 years, and every once in awhile we are going to check you out and you can be bounced at any time.

We do not do that in any other field. Maybe we should.

Senator **Pell**. Maybe we should in the Senate. [Laughter.]

Senator **Stafford**. In the Senate we do it; we have a thing called elections.

Senator **Pell**. As the chairman points out, we do. In connection with the—well, first let us get the answer from Dr. Graham, what her reaction is.

Ms. **Graham**. Teachers must start with a knowledge of the subject matter that is to be taught, and the knowledge of the subject matter that is to be taught is a necessary but not sufficient condition for good teaching.

Additional issues for teachers include pedagogical style, pedagogical skill, perspective on the educational enterprise, and concern for the welfare of children and their learning. But unless teachers are thoroughly competent in what it is that they are to teach, and unless they have enthusiasm for it, children will not learn.

Senator **Pell**. So, in other words, you approve of the idea that one of the tools in hiring would be passing a test. As you point out, it does not necessarily make you a great teacher.

Ms. **Graham**. I think there are a variety of ways to assess whether or not a teacher is competent in the subject matter. Testing is one of them. Performance in academic courses of rigorous merit is another. There are a variety of ways. To my mind, no single method has been devised that is satisfactory.

Senator **Pell**. Of course, if you tested one in math, we went through this phase of new math, and now, as I understand it—I never could understand new math—and now we have gone back to the old math. So that would make it very difficult to do.

Ms. **Graham**. It is a revised math; no question about that.

Mr. **McGuire**. Certainly, we believe that two things have to happen. One has to be in the whole area of teacher preparation and we favor a very strong teacher preparation program with high entrance requirements, a rigorous course study in the discipline to be taught, and work in education, working directly with young people, and rather than any single test, that a profile be kept including the entrance test scores, the grade point average within the rigorous following of the discipline, and then evaluation of that sensitive interraction that takes place between teacher and student that has been videotaped and observed.

And through that entire profile, we should have a better idea of finding those who have a high promise of success in that respect.

Senator **Pell**. You would not object to a test being one of the criteria?

Mr. **McGuire**. There would be many—a single—I would object to a single test of the person doing all that was expected of them during the 4 years and taking a single pencil and paper test at the end. But I believe there should be strong entrance requirements, many tests given during the rigorous course work, and evaluation all the way along so there was a profile to look at, rather than a single test at the end that said, you are in; you are out. I do not think that that is nearly as fair as a strong profile over the entire period.

Mr. **Shanker**. Senator, I would strongly disagree with that. I think that your grades in college are an indication of something. Sometimes they are an indication that the college gives easy grades. They are not an indication, very much—I do not know how we monitor whether a person has been in rigorous or tough courses and done well without some very extensive system, which I do not think this country wants to get into or ever will get into.

I do not see what is wrong—if prospective lawyers can take bar exams and doctors after going to medical school take examinations; actuaries take examinations. Everybody in our society takes examinations, not because we do not trust somebody, but because we do not have a system that absolutely will guarantee that the institutions are making proper certifications.

Now, if everyone else in our society can take a test and that test plays not the only role, but a very important role in determining whether that person moves into an occupation or a profession, I do not see why we cannot provide the same protection for our children that we provide for everybody else.

Senator **Pell**. I think you are right: from birth to death, the doctor has to do it and the undertaker has to do it. And you—I would agree with you.

I have no further questions.

Senator **Stafford**. Thank you very much, Senator Pell. And for the subcommittee, I want to express our appreciation to all three of you for being here. There will be some questions in writing, I can assure you, and we will look forward to your answers to those, as we have enjoyed your answers this morning here in person.

Thank you very much.

Mr. **Shanker**. Thank you.

Senator **Stafford**. The next panel will consist of Dr. E. K. Fretwell, chancellor of North Carolina University at Charlotte; Dr. Howard D. Mehlinger, dean, School of Education, University of Indiana at Bloomington, Ind.; the Reverend William J. Byron, president of Catholic University; Dr. Richard Brod, director, Association of Departments of Foreign Languages, Modern Language Association; and Dr. Joshua Smith, president, Borough of Manhattan Community College, New York, N.Y.

Welcome to all of you and our appreciation for your willingness to come here and assist this subcommittee in the job we have embarked upon on behalf of education. Again, I apologize for the lack of time we always seem to run into here. And I guess I explained to the earlier panel that stop and go system we have been forced to resort to, it gives you 4 minutes on the green, 1 minute on the yellow, and then the red.

And since we have your statements in full, we will place them in the record as if read and encourage you to summarize them within the timeframe, if you possibly can. Having said that, it would be the Chair's intent to go in the order in which we introduced the panel, if that is agreeable to members, which means Dr. Fretwell, you would proceed to be followed by Dr. Mehlinger, the Reverend Byron, Mr. Brod, and finally, Dr. Smith.

If that is agreeable, Dr. Fretwell, we will start with you.

STATEMENTS OF E. K. FRETWELL, JR., CHANCELLOR, UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE, ON BEHALF OF THE AMERICAN ASSOCIATION OF STATE COLLEGES AND UNIVERSITIES; HOWARD D. MEHLINGER, DEAN, SCHOOL OF EDUCATION, AND PROFESSOR OF EDUCATION AND HISTORY, INDIANA UNIVERSITY, BLOOMINGTON, IND.; REV. WILLIAM J. BYRON, PRESIDENT, CATHOLIC UNIVERSITY OF AMERICA; RICHARD BROD, DIRECTOR, FOREIGN LANGUAGE PROGRAMS, MODERN LANGUAGE ASSOCIATION, AND SECRETARY-TREASURER, JOINT NATIONAL COMMITTEE FOR LANGUAGES, WASHINGTON, D.C.; AND JOSHUA SMITH, PRESIDENT, BOROUGH OF MANHATTAN COMMUNITY COLLEGE, NEW YORK, N.Y., ON BEHALF OF THE AMERICAN ASSOCIATION OF COMMUNITY AND JUNIOR COLLEGES, AND THE ASSOCIATION OF COMMUNITY COLLEGE TRUSTEES

Mr. **Fretwell.** Thank you, Senator. I am E. K. Fretwell, chancellor of the University of North Carolina at Charlotte, and I am speaking today for those of us in North Carolina and also for 20 organizations listed on the cover of the testimony, which I am glad to present for the record.

I might say, incidentally, I am a former elementary and secondary schoolteacher. The current nature of the problem in science and mathematics education, I think, is so well known that I am not going to spend time this morning viewing with alarm. I think we are aware of the problem and that my colleagues on this panel and the earlier panel have made that very clear indeed.

I would like to suggest, however, that there may be some hope for the society as far as we are concerned, and one of the things that I find useful—and I hope it goes somewhere—is what appears to be a bipartisan recognition of the growing crisis.

President Reagan, in a message to the 1982 National Academy of Sciences convocation on sciences and math in the schools declared, "The problems today in elementary and secondary school science and mathematics education are serious, serious enough to compromise American's future ability to develop and advance our traditional industrial base to compete in international marketplaces."

A special task force on long-term economic policy in the House Democratic Caucus observed in a report called "Rebuilding the Road to Opportunity," and I quote from that source:

> In the future a well educated, well trained work force will be essential to sustained economic growth. The future will be won with brainpower. The research we must undertake to produce new technologies requires that, yet we are not graduating sufficient numbers of scientists, engineers, and technicians.

Now, there seems to be general agreement on the dimensions of the problem, but not yet consensus on the solution. And my view is that constructive actions are not needed at just one level, but simultaneously at the institutional, local, State, and National levels, and I would direct our attention to that for a few moments.

I would like to draw a little bit on the experience of North Carolina, not because we are unique, but because I know it best. Our experience serves as an important example of how a range of government and private resources have been used to build a high-technology base.

Our State has been successful in attracting high-technology industry because we have substantially invested in the State and local level in quality education from preschool through graduate and professional education, and we intend to do more.

Gov. Jim Hunt, the recently named chairman of the National Task Force on Education for Economic Growth, acknowledged the importance of the relationships when he spoke of productivity, profits, and progress. They go forward together. One of that task force's major goals will be to forge an alliance between government at various levels and business.

And I point out again that business, as well as national defense, has a heavy need to have well-prepared people from all segments of society.

Turning to the local scene, in one particular community, Charlotte, N.C., we have recently put together but not yet fully funded a cooperative arrangement in which all of these elements are working toward the common goal: improvement of science, mathematics, and technology education. In brief, a campuswide approach to the preparation of teachers and getting away from some of the turf problems which have plagued teacher education in the past; a really superb working arrangement with the Charlotte-Mecklenburg countywide public school systems in a variety of ways.

For example, we held a large mathematics contest for kids who are doing well in math on our campus yesterday; we have an arrangement with Discovery Place, a hands-on-science museum, in which our university is sharing a staff person with them.

We have instituted a broad-based community advisory committee to be chaired by a scientist from a major technology corporation in the university research park at Charlotte. We maintain close working relations with the State department of public instruction, Governor Hunt's office of science and technology, the Microelectronics Center of North Carolina, and various others.

And I might mention that Operation Pipeline, which is being funded by industry through our engineering school, is seeking out talent at the junior high level among all students with heavy emphasis on minorities and female students so that we do not get into the problem which Dean Graham indicated earlier of science being, up to now, largely a field of white males.

Now, we recognize that teaching and learning take place in a local context, but we focus attention on the vital role which the Federal Government must play, for reasons, I think, that are abundantly clear. And we are proposing on behalf of our constituency, the 20 organizations mentioned, three programs:

A $100 million program providing opportunities for teachers, young scholars, and researchers through expanded graduate fellowships. This would be under the Department of Education.

A program to strengthen educational research in mathematics, science, and technology education, involving the National Institute of Education in cooperation with the National Science Foundation.

A program of opportunities for teachers, young scholars, and researchers through expanded fellowships, traineeships, and so forth, through the National Science Foundation. The amounts are indicated in the prepared testimony which I have submitted for all of these.

A program to upgrade and improve instructional programs in mathematics, science, and technology, all levels, through NSF.

And finally, a program to upgrade undergraduate instructional equipment and its utilization—$200 million through NSF.

Summarizing these—and again, I point out that the details are in the document—we are proposing a $575 million project, an approach which will enable the Federal Government to spend as much money on this as it spends perhaps on two or three aircraft. And I present the idea that this, a commitment to math and science education, is another form of, a very vital form of, national defense.

Thank you, gentlemen.

[The prepared statement of Mr. Fretwell follows:]

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Statement by

E. K. Fretwell, Jr.

Chancellor

University of North Carolina at Charlotte

on

Science, Mathematics and Technology Education Legislation

On Behalf of

American Association of State Colleges and Universities

and

American Association of Colleges for Teacher Education
American Association of Community and Junior Colleges
American Council on Education
American Educational Research Association
Association of Affiliated College and University Offices
Association of American Colleges
Association of American Publishers
Association of American Universities
Association of Catholic Colleges and Universities
Association of Jesuit Colleges and Universities
Association of Urban Universities
California State University
Council of Graduate Schools in the United States
Council of Independent Colleges
National Association for Equal Opportunity in Higher Education
National Association of College and University Business Officers
National Association of Independent Colleges and Universities
National Association of Schools and Colleges of the United Methodist Church
National Association of State Universities and Land-Grant Colleges
State University of New York

Before the
Senate Subcommittee on Education Arts and Humanities
U.S. Senate

March 9, 1983

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Cable Address: AASCU Washington, D.C.

My name is E. K. Fretwell and I am Chancellor of the University of North Carolina at Charlotte, one of the 16 campuses of the University of North Carolina System. A former college teacher I have also served as the President of State University of New York College at Buffalo, a University Dean at the City University of New York and as Assistant Commissioner for the Higher Education of New York State.

I served in such elected offices as Chair of the American Council on Education, President of American Association of State Colleges and Universities, Chair of the Board of the Carnegie Foundation for the Advancement of Teaching, President of the Middle States Association of Colleges and Schools and President of the American Association for Higher Education.

I am pleased to have the opportunity to appear before this Subcommittee to testify on the needs for science, mathematics and technology education legislation.

I represent the 354 member institutions of the American Association of State Colleges and Universities (AASCU). With a combined enrollment of close to 2 1/2 million students the 354 state colleges and universities of AASCU enroll one out of five of all baccaulaureate degree students in the country. Our institutions play a major role in our nation's science effort. Many students who ultimately pursue advanced degrees in scientific and technical fields received their basic undergraduate training at our institutions. A large portion of the nation's future elementary and secondary school science and mathematics teachers are educated at AASCU colleges and universities. These teachers must be able to communicate the knowledge and skills that will enable youth to live in an increasingly complex and technology-dependent society. AASCU institutions award close to one-fifth of the B. S. degrees in engineering annually and over one-third of the B.S. degrees in computer and information sciences.

In addition, I am also speaking on behalf of the 21 associations who participated in the development of "Higher Education's Agenda in Science, Mathematics and Technology Education." These associations collectively include the over 3,000 degree granting american colleges and universities who will pay a major role in the economic revitalization and technogical advancement of this nation.

Current Nature of the Problem in Science Education

The current national crisis in science, mathematics and technology education is a threat to our future economic survival and military security. The dimensions of the problem confronting our nation are broad. For example,

- o documented declines in student achievement in mathematics and sciences. Average science and mathematics scores on standardized college entrance tests have been dropping steadily for 20 years;
- o a serious shortage of qualified mathematics and science teachers. During the 1970's the number of secondary

school mathematics teachers being trained declined 77 percent; science teachers being trained declined 65 percent. Some 50 percent of newly employed teachers nationwide are currently uncertified and unqualified to teach mathematics and science. This situation is exacerbated by the rapid departure of trained classroom teachers for better paying jobs in industry;

- at least 2,000 vacant faculty positions in university engineering departments. These vacancies have resulted in enrollment limits which, in turn, impede the training of adequate number of B.S. engineers;
- the obsolescence of much of the instrumentation and equipment used in college and university laboratories has been well documented;
- tens of thousands of technicians openings are going begging even as the national rate of unemployment approaches 11 percent. The Congressional Budget Office projects that new technologies will make three million more jobs obsolete by the end of this century;
- secondary students are taking fewer courses in math and science than in years past, and fewer courses are being offered. Half of all U.S. high school students take no mathematics after the tenth grade, while in other industralized nations, particularly Japan and Germany, in-

creasing emphasis is being placed on science and mathematics education;

- since 1972 there has been a 54 percent decline in the number of Ph.D.'s awarded in engineering yearly to U.S. nationals, while Ph.D.'s in engineering awarded to foreign students have more than doubled; and
- Japan, one of our primary competitors in the world marketplace, produces twice as many engineers as we do even though their populations base is half ours. From 1970 to 1977 the number of engineers per 1,000 workers increased by 48 percent in Japan and decreased by nine percent in the U.S.

There is a bipartisan regognition of this growing crisis. President Reagan, in a message to the 1982 National Academy of Sciences Convocation on Science and Mathematics in the Schools, declared; "The problems today in elementary and secondary school science and mathematics education are serious -- serious enough to comprise America's future ability to develop and advance our traditional industrial base to compete in international market places." The Special Task Force on Long Term Economic Policy of the House Democratic Caucus observed in the report Rebuilding the Road to Opportunity: "in the future, a well-educated, well-trained workforce will be essential to sustained economic growth ... the future will be won with brainpower... The research we must undertake to produce new technologies requires that -- yet we are not graduating sufficient numbers of scientists, engineers and technicians."

Although there is now general agreement on the dimensions of the problem, there is no consensus on the solution. Constructive actions at the institutional, local, state, and national levels are necessary to forestall a further deterioration.

Appropriate Response to the Problem

If we are successfully to forestall further erosion within our scientific educational system, we must look for solutions at all levels of government and in partnership with the private sector. The stakes are too high and the consequences of inaction are too great for any institution in our society, public or private, to ignore the current crisis.

I believe strongly that there must be a federal-state-private sector push for higher levels of achievement in science, mathematics and technology education at all levels. Only will this coordinated effort begin to restore our lagging state of science literacy.

The North Carolina experience serves as an important example of how a range of government and private resources have been used to build a high technology base in our state.

North Carolina has been successful in attracting high technology industry because we have substantially invested on the state and local level in quality education from preschool through graduate and professional education.

Governor Jim Hunt, the recently named Chairman of the National Task Force on Education for Economic Growth, acknowledged the importance of this relationship of training and education investments yielding in "productivity, profits and progress"; one of the Task Force's major goals will be to forege an alliance between government, at various levels, and business, all of which have a stake in the future strength of our education system.

Let me tell you a bit about our efforts in Charlotte, North Carolina. Recently we have managed to put together a cooperative arrangement in which all these elements are working towards the common goal -- improvement of science, mathematics and technology education. For example,

-- we have a campus-wide approach to the preparation and upgrading of teachers of science and mathematics in the schools which involves the science and mathematics departments, as well as appropriate individuals from teacher education;

-- we have an excellent working relationship with the Charlotte-Mecklenburg county-wide school system which involves communications both at the Chancellor to Superintendent level, as well as face to face acquaintanceship of specialists in math and science on campus and in the schools; for example, several hundred high school math students and their teachers were on our campus yesterday (March 8) for the University of North Carolina at Charlotte 4th Annual Mathematics Contest. Another example is "Operation Pipeline" in which our faculty, especially in engineering, works with junior high people to stimulate sequential commitment in math and sciences, particularly by female students and minorities.

-- we have an arrangement with Discovery Place/Science Museum, a "hands-on" science museum located in Charlotte, whereby we share a staff person (a science educator) who is currently working to develop proposals to upgrade math and science teachers;

-- we are developing a broad based advisory committee including people from the community and headed by a scientist from a major technology corporation. They will advise us in a variety of cooperative efforts; and

-- we consult with various other campuses in the UNC system, the State Department of Public Instruction and the appropriate individuals in Governor Hunt's Office of Science and Technology (which has already taken a major leadership role in stimulating math and science instruction), as well as the Microelectronics Center of North Carolina which is helping expand high technology in our state.

We think that this approach works well. It illustrates how state, local and private resources can all be marshalled in an appropriate way to deal with a critical issue.

The Federal Role

Although teaching and learning take place in a local context, the federal government must play a central role in providing leadership and support for a variety of science, mathematics, health and technology education initiatives. Sustained federal investment is required because the problems are national in scope and because failure to resolve them would have grave implications for our national well-being and defense capability. These investment will maximize the return on scarce federal resources, encourage local and individual initiatives, minimize federal control of these efforts, and provide incentives for collaboration among all sectors.

America's postsecondary institutions -- two-year, four-year, and graduate -- all have a major role to paly in restoring our economic health and bolstering our national defense. Their resources should be directed to the most critical problems that beset the science education system so that adequate numbers of qualified mathematics and science school teachers will be trained; education for technology and science-related careers will be provided; the proper research environment, experience and tools to train the next generation of scientists, engineers and researchers will be encouraged; and research to improve instruction and the educational uses of information technology will be supported. With such steps students will be sufficiently science-literate to live in an increasingly technological world and have the opportunity to prepare for careers in the sciences; and currently employed teachers, engineers, scientists and researchers will have opportunities to upgrade their skills.

The 98th Congress is called upon to enact major legislation that will enable colleges and universities to fulfill further their mission as a vital force in solving the current science, mathematics, and technology education crisis.

This Congress has already signalled its intention to place science, mathematics and technology education legislation high on its agenda. Last week the House of Representatives overwhelmingly, and by a bi-partisan vote, passed H.R. 1310, the Emergency Mathematics and Science Education Act. This bill is to be viewed as an important first step in revitalizing the Federal role in science education. Your decision to hold these hearings on the need for new Federal science education is likewise a positive step forward. The various legislative initiatives introduced by members of this Subcommittee, and other members of the Senate, are important foundations for the construction of new Federal legislation.

As a guideline for this Subcommittee to reach decisions about appropriate Federal legislation, I would like to tell you about "Higher Education's Agenda for Science, Mathematics and Technology Education." (Attached.) The 21 associations that participated in the development of this agenda support the establishment of five new programs to be administered by the Department of Education and the National Science Foundation. These programs represent the top priorities of the higher education community regarding science, mathematics and technology education. Each is an essential component of the total effort needed in this area.

For the Department of Education, we propose two programs: a $200 million program for teacher training initiatives to improve science, mathematics and technology education, and a $25 million program to strengthen educational research in these areas.

For the National Science Foundation, we propose three programs: a $100 million program providing opportunities for teachers, young scholars and researchers through expanded graduate fellowships, a new traineeships and faculty research awards; a $50 million program to upgrade and improve instructional programs on all levels; and a $200 million program to upgrade instructional equipment and its utilization.

The total $575 million dollar federal investment proposed provides a significant number and variety of new awards to individuals, schools, and colleges. Coupled with local, state and private sector initiatives, these programs will make a substantial contribution toward the revitalization of the science education in the nation.

In embarking on this new federal effort in sciences, math and technology education we must acknowledge the importance of a sustained national commitment to basic research. Without quality research programs, the education enterprise will wither. Our proposal for new federal support of science education should be viewed as an integral part of this commitment. Both research and education are necessary for the economic vitality and defense strength of the United States. Neither should be funded at the expense of the other.

Title: A Program for Teacher Training Initiatives to Improve Science, Mathematics and Technology Education

Agency:	Department of Education
Authorization:	$200 million
Target:	3,000 grants at up to $200,000 each to schools and colleges

We propose the establishment of a grant program for schools, colleges and universities to be administered by the Department of Education with proposals to be evaluated through a peer review process involving consultation with NSF to identify field readers. The purpose of these grants is to encourage the linkage between colleges and universities and public and private elementary and secondary schools in the improvement of science education. Grants would allow maximum institutional flexibility to be responsive to local needs, and would be awarded according to plans developed by the recipient institution in collaboration with one or more public or private schools or school districts and other appropriate agencies or councils. Priority activities might include, for example:

(1) summer institutes and workshops and a parallel program of inservice education, conducted by higher education institutions across all states and regions to provide practicing teachers and supervisors with up-to-date science and mathematics information and pedagogical concepts;

(2) projects to enhance the capacity of schools and colleges to meet the professional needs of both new and practicing teachers, including faculty development activities; and

(3) support for exemplary state, local and institutional efforts to attract, retain and motivate teachers to pursue careers in precollege mathematics and science education, as well as identification of teacher training projects providing nationally significant examples of campus-based inservice, school site staff development, and the integration of substantive knowledge in

mathematics and the sciences with effective teaching strategies, and the dissemination of information about these programs.

Title: A Program to Strengthen Educational Research in Mathematics/Science and Technology Education

Agency:	National Institute of Education, in consultation with the National Science Foundation
Authorization:	$25 million
Target:	New grant competitions for specific research yielding 10 major programmatic awards, and up to 200 individual research grants.

Research on student learning and school and college instruction in math, science, and technology education (particularly focused on secondary schools) is an essential resource for other federal, state and local programs for improving math and science education.

We propose a new program to strengthen teaching and learning research through grants focused on the identification of successful instruction and the application of cognitive research to improved instructional programs. The program will support large scale research competitions dealing with:

(1) research on thinking, teaching and learning related to instruction in math, science and technology;

(2) research on the uses of modern instructional technologies; the status, means of assessment, and selection of instructional software and other mathematics, science

and technology education materials;

(3) research on local, state and institutional policies enhancing or inhibiting the recruitment, retention and professional development of school and college math and science faculties; and

(4) research on school, institution and state needs and operations as they relate to the development and support of remedial programs at all levels of education.

Title: A Program of Opportunities for Teachers, Young Scholars and Researchers through Expanded Fellowships, New Traineeships, Research Incentive Awards, and Faculty Awards for Summer Study

Agency:	National Science Foundation
Authorization:	$100 million
Target:	$ 15 million to expand existing graduate fellowships and to create 600 new graduate fellowships; $15 million for new institutional traineeship programs; $50 million for 1,000 new faculty research incentive awards; $20 million for faculty awards for summer study sabbaticals and special research opportunities.

We propose the establishment of a series of new and expanded programs to provide fellowships, traineeships, summer study support, research inventive awards, and faculty renewal awards to increase the production of scientists, engineering faculty, researchers and science educators, and to upgrade teaching faculty.

Four programs should be supported in this area:

(1) An expanded Graduate Fellowship Program. The structure and effectiveness of the NSF Graduate Fellowship Program, once a premier symbol of the nation's commitment to excellence, has diminished steadily over the years. The NSF fellowship program should be expanded by increasing the number of awards and the amount of the stipend. To achieve this, we propose at least doubling the amount of money available for these fellowships (from $15 million to 30 million) and increasing by approximately one-third both the number and size of the current award (from 1,400 to 2,000 and at least $15,000 rather than $10,900 per award).

(2) A new $15 million Traineeship Program for science, technology and mathematics educators. Awards of up to $150,000 would be made to colleges and universities. Trainees would be selected by participating departments, schools and institutions from among individuals with demonstrated potential to excel as science, technology and mathematics educators at elementary/secondary and undergraduate levels. Institutions receiving traineeships would gather education specialists and faculty from departments of science, mathematics and technology to create for the trainee a new or improved quality program for preparing the next generation of science educators.

(3) A new $50 million Young Faculty Research Incentive Awards Program. The challenges facing young faculty who seek to establish their first research programs are almost overwhelming. A program offering stable support (averaging $50,000 per year per award) to assist them in starting academic research careers would help to sustain the quality and flow of individuals into key fields of science, mathematics, engineering and technology. $1,000 awards would be authorized to average $50,000 per year.

(4) A new $20 million program of Faculty Awards for summer study, sabbaticals, and special research opportunities. This program would provide 3,000 awards at $5,000 each for summer support to permit currently employed faculty to take advantage of upgrading opportunities; and a $5 million program for experienced faculty for six- to twelve-month periods at salary equivalent to current levels to: (a) permit revitalization, and experience with new research techniques and advanced research discoveries for those who have been isolated from research institutions and centers for six or more years; and (b) to provide for intensive development of teaching techniques and materials in problem areas. A total of $20 million authorized in this area will provide awards on a competitive basis to individuals whose institutions certify that the applicant's

principal function is undergraduate teaching in a science-related discipline.

Title: A Program to Upgrade and Improve Instructional Programs in Mathematics, Science and Technology at All Levels

Agency:	National Science Foundation
Authorization:	$50 million
Target:	1,000 instructional improvement projects at up to $200,000 each.

Continuing demands are placed on science educators to keep pace with evolving technological innovations. Updated instructional materials are needed to enhance student motivation and to advance the lagging state of science learning. The need for new instructional materials is particularly acute at the undergraduate level for both general students and science and engineering majors.

We propose a new program to improve undergraduate instructional programs and develop school and college materials for mathematics, science and technology education.

Priority areas include:

(1) restructuring subject matter science courses to reflect state-of-the-art technology and the changing needs of undergraduates;

(2) applying teaching and learning research concepts to the development of mathematics, science and technology instructional materials for schools and colleges; and

(3) stimulating collaborative educational institution/industry efforts in the development of improvement programs for school and colleges.

Title: A Program to Upgrade Undergraduate Instructional Equipment and Its Utilization

Agency:	National Science Foundation
Authorization:	$200 million
Target:	Grants to colleges and universities

The outmoded condition of the instructional equipment in the nation's colleges and universities is well-documented. The absence of state-of-the-art equipment and facilities has immediate consequences in the preparation of today's students, and far reaching implications for the nation's ability to remain scientifically and technologically competitive.

We propose a two-part program for:

(1) acquisition and installation of modern instructional equipment for use in teaching and training for teaching; and

(2) sharing science equipment among institutions regionally and between the academic and business sectors.

We further suggest that a balanced program is needed involving all federal agencies that support research and related education programs to make the acquisition of equipment and renovation of laboratories an allowable component of research proposals.

Conclusion

The $575 million program that I have described is an important investment in our country's future. The erosion within our science education system can no longer be ignored. Our nation's colleges and universities call upon you to approve legislation that will begin to restore our economic vitality and military strength.

HIGHER EDUCATION'S AGENDA IN MATHEMATICS, SCIENCE AND TECHNOLOGY EDUCATION

Background

America's productivity, economic welfare and national defense are threatened by the growing crisis in our education system. Awareness of this problem manifested itself during the 97th Congress in numerous legislative proposals, reports of the National Science Board Commission on Precollege Education in Mathematics, Science and Technology, the proliferation of private sector programs, and widespread media attention.

The dimensions of the problem are multifaceted and permeate our educational system from the precollege level to the community college, the undergraduate classrooms and the graduate universities. There is considerable evidence of the decline of our scientific educational system:

- documented declines in student achievement in mathematics and sciences. Average science and mathematics scores on standardized college entrance tests have been dropping steadily for 20 years;

- a serious shortage of qualified mathematics and science teachers. During the 1970's the number of secondary school mathematics teachers being trained declined 77 percent; science teachers being trained declined 65 percent. Some 50 percent of newly employed teachers nationwide are currently uncertified and unqualified to teach mathematics and science. This situation is exacerbated by the rapid departure of trained classroom teachers for better paying jobs in industry;

- at least 2,000 vacant faculty positions in university engineering departments. These vacancies have resulted in enrollment limits which, in turn, impede the training of adequate numbers of B.S. engineers;

- the obsolescence of much of the instrumentation and equipment used in college and university laboratories has been well documented;

- tens of thousands of technician openings are going begging even as the national rate of unemployment approaches 11 percent. The Congressional Budget Office projects that new technologies will make 3 million more jobs obsolete by the end of this century;

- secondary students are taking fewer courses in math and science than in years past, and fewer courses are being offered. Half of all U.S. high school students take no mathematics after the tenth grade, while in other industrialized nations, particularly Japan and Germany, increasing emphasis is being placed on science and mathematics education;

- since 1972 there has been a 54 percent decline in the number of Ph.D.'s awarded in engineering yearly to U.S. nationals, while Ph.D.'s in engineering awarded to foreign students have more than doubled; and

- Japan, one of our primary competitors in the world marketplace, produces twice as many engineers as we do even though their population base is half ours. From 1970 to 1977 the number of engineers per 1,000 workers increased by 46 percent in Japan and decreased by 9 percent in the U.S.

There is bipartisan recognition of this growing crisis. President Reagan, in a message to the 1982 National Academy of Sciences Convocation on Science and Mathematics in the Schools, declared: "The problems today in elementary and secondary school science and mathematics education are serious -- serious enough to compromise America's future ability to develop and advance our traditional industrial base to compete in international marketplaces." The Special Task Force on Long Term Economic Policy of the House Democratic Caucus observed in its report Rebuilding the Road to Opportunity: "in the future, a well-educated, well-trained workforce will be essential to sustained economic growth . . . the future will be won with brainpower . . . The research we must undertake to produce new technologies requires talent -- yet we are not graduating sufficient numbers of scientists, engineers and technicians."

The Federal Role

Although there is now general agreement on the dimensions of the problem, there is no consensus on the solution. The higher education community views the current crisis with alarm. Constructive actions at the institutional, local, state, and national levels are necessary to forestall a further deterioration.

We believe the federal government must play a central role in providing leadership and support for a variety of initiatives outlined in the following pages. Sustained federal investment is required because the problems are national in scope and because failure to resolve them would have grave implications for our national well-being and defense capability. These investments will maximize the return on scarce federal resources, encourage local and individual initiatives, minimize federal control of these efforts, and provide incentives for collaboration among all sectors.

America's postsecondary institutions -- two-year, four-year, and graduate -- all have a major role to play in restoring our economic health and bolstering our national defense. Their resources should be directed to the most critical problems that beset the science education system so that adequate numbers of qualified mathematics and science school teachers will be trained; education for technology and science-related careers will be provided; the proper research environment, experience and tools to train the next generation of scientists, engineers and researchers will be encouraged; and research to improve instruction and the educational uses of information technology will be supported. With such steps students will be sufficiently science-literate to live in an increasingly technological world and have the opportunity to prepare for careers in the sciences; and currently employed teachers, engineers, scientists and researchers will have opportunities to upgrade their skills.

Thus we urge the 98th Congress to enact major legislation that will enable colleges and universities to further fulfill their mission as a vital force in solving the current science, mathematics, and technology education crisis. The higher education community recognizes the interrelationship among all levels of education in resolving the crisis and supports the efforts of the precollege sector to solve their own unique and compelling problems. However, this paper attempts only to address the crisis from the perspectives of higher education.

Proposed Federal Program

The higher education community -- collectively listed at the end of this paper -- supports the establishment of five new programs to be administered by the Department of Education and the National Science Foundation. These programs represent the top priorities of the higher education community regarding science, mathematics and technology education. Each is an essential component of the total effort needed in this area.

For the Department of Education, we propose two programs: a $200 million program for teacher training initiatives to improve science, mathematics and technology education, and a $25 million program to strengthen educational research in these areas.

For the National Science Foundation, we propose three programs: a $100 million program providing opportunities for teachers, young scholars and researchers through expanded graduate fellowships, new traineeships and faculty research awards; a $50 million program to upgrade and improve instructional programs on all levels; and a $200 million program to upgrade instructional equipment and its utilization.

The total $575 million dollar federal investment proposed provides a significant number and variety of new awards to individuals, schools, and colleges. Coupled with local, state and private sector initiatives, these programs will make a substantial contribution toward the revitalization of the science education in the nation.

In embarking on this new federal effort in sciences, math and technology education we must acknowledge the importance of a sustained national commitment to basic research. Without quality research programs, the education enterprise will wither. Our proposal for new federal support of science education should be viewed as an integral part of this commitment. Both research and education are necessary for the economic vitality and defense strength of the U.S. Neither should be funded at the expense of the other.

Title: A Program for Teacher Training Initiatives to Improve Science, Mathematics and Technology Education

Agency:	Department of Education
Authorization:	$200 million
Target:	3,000 grants at up to $200,000 each to schools and colleges

We propose the establishment of a grant program for schools, colleges and universities to be administered by the Department of Education with proposals to be evaluated through a peer review process involving consultation with NSF to identify field readers. The purpose of these grants is to encourage the linkage between colleges and universities and public and private elementary and secondary schools in the improvement of science education. Grants would allow maximum institutional flexibility to be responsive to local needs, and would be awarded according to plans developed by the recipient institution in collaboration with one or more public or private schools or school districts and other appropriate agencies or councils. Priority activities might include, for example:

(1) summer institutes and workshops and a parallel program of inservice education, conducted by higher education institutions across all states and regions to provide practicing teachers and supervisors with up-to-date science and mathematics information and pedagogical concepts;

(2) projects to enhance the capacity of schools and colleges to meet the professional needs of both new and practicing teachers, including faculty development activities; and

(3) support for exemplary state, local and institutional efforts to attract, retain and motivate teachers to pursue careers in precollege mathematics and science education, as well as identification of teacher training projects providing nationally significant examples of campus-based inservice, school site staff development, and the integration of substantive knowledge in mathematics and the sciences with effective teaching strategies, and the dissemination of information about these programs.

Title: A Program to Strengthen Educational Research in Mathematics/Science and Technology Education

Agency:	National Institute of Education, in consultation with the National Science Foundation
Authorization:	$25 million
Target:	New grant competitions for specific research yielding 10 major programmatic awards, and up to 200 individual research grants.

Research on student learning and school and college instruction in math, science, and technology education (particularly focused on secondary schools) is an essential resource for other federal, state and local programs for improving math and science education.

We propose a new program to strengthen teaching and learning research through grants focused on the identification of successful instruction and the application of cognitive research to improved instructional programs. The program will support large scale research competitions dealing with:

(1) research on thinking, teaching and learning related to instruction in math, science and technology;

(2) research on the uses of modern instructional technologies; the status, means of assessment, and selection of instructional software and other mathematics, science and technology education materials;

(3) research on local, state and institutional policies enhancing or inhibiting the recruitment, retention and professional development of school and college math and science faculties; and

(4) research on school, institution and state needs and operations as they relate to the development and support of remedial programs at all levels of education.

Title: A Program of Opportunities for Teachers, Young Scholars and Researchers through Expanded Fellowships, New Traineeships, Research Incentive Awards, and Faculty Awards for Summer Study

Agency:	National Science Foundation
Authorization:	$100 million
Target:	$15 million to expand existing graduate fellowships and to create 600 new graduate fellowships; $15 million for new institutional traineeship programs; $50 million for 1,000 new faculty research incentive awards; $20 million for faculty awards for summer study sabbaticals and special research opportunities.

We propose the establishment of a series of new and expanded programs to provide fellowships, traineeships, summer study support, research incentive awards, and faculty renewal awards to increase the production of scientists, engineering faculty, researchers and science educators, and to upgrade teaching faculty.

Four programs should be supported in this area:

(1) An expanded Graduate Fellowship Program. The structure and effectiveness of the NSF Graduate Fellowship Program, once a premier symbol of the nation's commitment to excellence, has diminished steadily over the years. The NSF fellowship program should be expanded by increasing the number of awards and the amount of the stipend. To achieve this, we propose at least doubling the amount of money available for these fellowships (from $15 million to $30 million) and increasing by approximately one-third both the number and size of the current awards (from 1,400 to 2,000 and at least $15,000 rather than $10,900 per award).

(2) A new $15 million Traineeship Program for science, technology and mathematics educators. Awards of up to $150,000 would be made to colleges and universities. Trainees would be selected by participating departments, schools and institutions from among individuals with demonstrated potential to excel as science, technology and mathematics educators at elementary/secondary and undergraduate levels. Institutions receiving traineeships would gather education specialists and faculty from departments of science, mathematics and technology to create for the trainee a new or improved quality program for preparing the next generation of science educators.

(3) A new $50 million Young Faculty Research Incentive Awards Program. The challenges facing young faculty who seek to establish their first research programs are almost overwhelming. A program offering stable support (averaging $50,000 per year per

award) to assist them in starting academic research careers would help to sustain the quality and flow of individuals into key fields of science, mathematics, engineering and technology. 1,000 awards would be authorized to average $50,000 per year.

(4) A new $20 million program of Faculty Awards for summer study, sabbaticals, and special research opportunities. This program would provide 3,000 awards at $5,000 each for summer support to permit currently employed faculty to take advantage of upgrading opportunities; and a $5 million program for experienced faculty for six- to twelve-month periods at salary equivalent to current levels to: (a) permit revitalization, and experience with new research techniques and advanced research discoveries for those who have been isolated from research institutions and centers for six or more years; and (b) provide for intensive development of teaching techniques and materials in problem areas. A total of $20 million authorized in this area will provide awards on a competitive basis to individuals whose institutions certify that the applicant's principal function is undergraduate teaching in a science-related discipline.

Title: A Program to Upgrade and Improve Instructional Programs in Mathematics, Science and Technology at All Levels

Agency:	National Science Foundation
Authorization:	$50 million
Target:	1,000 instructional improvement projects at up to $200,000 each.

Continuing demands are placed on science educators to keep pace with evolving technological innovations. Updated instructional materials are needed to enhance student motivation and to advance the lagging state of science learning. The need for new instructional materials is particularly acute at the undergraduate level for both general students and science and engineering majors.

We propose a new program to improve undergraduate instructional programs and develop school and college materials for mathematics, science and technology education.

Priority areas include:

(1) restructuring subject matter science courses to reflect state-of-the-art technology and the changing needs of undergraduates;

(2) applying teaching and learning research concepts to the development of mathematics, science and technology instructional materials for schools and colleges; and

(3) stimulating collaborative educational institution/industry efforts in the development of improved programs for schools and colleges.

Title: A Program to Upgrade Undergraduate Instructional Equipment and Its Utilization

Agency:	National Science Foundation
Authorization:	$200 million
Target:	Grants to colleges and universities

The outmoded condition of the instructional equipment in the nation's colleges and universities is well-documented. The absence of state-of-the-art equipment and facilities has immediate consequences in the preparation of today's students, and farreaching implications for the nation's ability to remain scientifically and technologically competitive.

We propose a two-part program for:

(1) acquisition and installation of modern instructional equipment for use in teaching and training for teaching; and

(2) sharing science equipment among institutions regionally and between the academic and business sectors.

We further suggest that a balanced program is needed involving all federal agencies that support research and related education programs to make the acquisition of equipment and renovation of laboratories an allowable component of research proposals.

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N. B.: Existing laws and recent legislative proposals have attempted to utilize the mechanism of tax incentives to encourage a corporate response to the science education crisis. We regard these proposals as one aspect of the total effort needed to resolve the urgent problems faced by higher education institutions. These proposals are uniquely well-suited to bringing private sector resources into play. Since this paper addresses only the necessary role of the federal government in the direct provision of support, we have omitted references to these tax incentive proposals.

This proposal is submitted on behalf of the following organizations:

American Association of Colleges for Teacher Education
American Association of Community and Junior Colleges
American Association of State Colleges and Universities
American Council on Education
American Educational Research Association
Association of Affiliated College and University Offices
Association of American Colleges
Association of American Universities
Association of Catholic Colleges and Universities
Association of Jesuit Colleges and Universities
Association of Urban Universities
California State University
Council of Graduate Schools in the United States
Council of Independent Colleges
National Association for Equal Opportunity in Higher Education
National Association of College and University Business Officers
National Association of Independent Colleges and Universities
National Association of Schools and Colleges of the United Methodist Church
National Association of State Universities and Land-Grant Colleges
State University of New York

Senator STAFFORD. Thank you very much, Doctor. We really appreciate your statement.

Dr. Mehlinger, you are next.

Mr. MEHLINGER. Thank you, Mr. Chairman and Senator Pell. I am Howard Mehlinger, dean of the School of Education at Indiana University. I am pleased to be invited to speak to this committee this morning on problems of math, science, and foreign language education.

Mr. Chairman, in your letter of invitation, you asked me to address three topics: the nature and magnitude of the problem; appropriate response to these problems at various levels of government and by the private sector; and appropriate Federal legislative response.

In the written testimony I have prepared and made available to the committee, I provide details on each of these.

In the few minutes available, let me hit only the high points of each of these three topics. First of all, on the nature and magnitude of the problem, I think the problem is more serious than the statistics suggest. The reason this is true is that the ascribed shortages of teachers of math, science, foreign languages, and so on, refer to existing shortages. But, as Secretary Bell indicated this morning, many of the States are in the process of increasing their high school graduation requirements.

For example, in Indiana, the State board of education plans to double the high school graduation requirements for math and science, so that in our State, which already registers a critical shortage, we shall simply double that shortage immediately with the introduction of the new requirements.

Second, it seems to me that the focus has been almost exclusively on the secondary grades and how we solve problems in the secondary grades; while this morning Senator Kennedy and Mr. Shanker have both pointed out, that the problem actually begins in the elementary grades where the foundations for science, math, and foreign language are laid.

Unless students are given proper instruction in the elementary grades, unless they have an introduction to these subjects early, they will develop fears and phobias about math and science. As a result they are unlikely to pursue math and science in the secondary grades, and they most certainly are not going to pursue such studies in college.

The second topic was what kind of a response to these problems should be made at various levels of government, particularly State and local governments, and the private sector.

I think it is important for the committee and for Congress to view the solution to this problem as one of striking an appropriate partnership. This partnership ought to be built across all levels of government: State, local, and Federal. It also needs to occur across levels of schooling; that is, cooperation is required between elementary and secondary schools and higher education and clearly a partnership is needed between the public and private sectors.

Therefore, it is necessary for Congress to pay some attention to what is actually going on in the other sectors as it fashions its own legislative solution, so that the Federal Government complements rather than replaces or duplicates what others are doing.

In Indiana, for example, the general assembly is at this very moment considering legislation relating to forgivable loans and scholarships for people to enter math and science education. It also intends to provide fellowships for people in subject areas other than math, who might wish to attend summer institutes in order to be trained as math and science teachers.

The State of Indiana will provide tax incentives for business to employ math and science teachers in the summer as a way of supplementing their income. Therefore, the Federal effort ought to take these and similar State efforts into consideration as it fashions its own solution.

There are some things that the Federal Government might examine as it tries to makes its own contribution in this area. There are also things it might avoid such as dribbling out too little money over too many different kinds of things. Otherwise, there will not be enough money in any one area to contribute very much to the solution. Second, as I have already pointed out, please avoid redundancy. Do not simply duplicate what other sectors are doing.

There are some things that ought to be done—some have already been proposed, some are in the legislation you are currently considering. But there are at least two areas that have not received much attention; I wish to comment on these briefly.

First of all, I think much has been made of the fact that many of the elementary and secondary schools are poorly equipped. I don't know that anyone has mentioned so far that teacher education institutions are themselves ill equipped

At Indiana University, as in many other teacher education colleges across the country, we now require teachers become competent in the use of computers as part of gaining teacher certification. Yet, there are very few teacher education institutions that have adequately equipped microcomputer labs, thus teacher education departments are trying to teach their teachers how to become proficient in the use of computers with very little equipment of their own.

You might think about properly equipping schools of education with microcomputers and up-to-date science labs.

And, second, I think you might want to give consideration to establishing four or five model centers for math, science, and foreign language that could attend to problems relating to curriculum development. Clearly, if we are going to do something in the elementary grades, if we are going to meet new math and science requirements appropriately for those who are not going to go on to college, there is a host of new curriculum problems that must be addressed. I think four or five model centers scattered around the country in locations that possess expertise in fields of critical shortage would be an important contribution to this effort.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Mehlinger follows:]

"Problems of Mathematics, Science, and Foreign Language Education"

Testimony Presented to

The Senate Subcommittee on Education,
Arts, and Humanities

Senator, Robert T. Stafford, Chairman

by

Dr. Howard D. Mehlinger
Dean, School of Education, and
Professor of Education and History
Indiana University
Bloomington, Indiana

March 9, 1983

Mr. Chairman and Members of the Committee:

I am Howard D. Mehlinger, Dean of the School of Education and Professor of History and Education at Indiana University. I am pleased to have this opportunity to appear before you today to discuss issues relating to needed improvements in mathematics, science, foreign language and technology education in American schools and colleges.

In your letter inviting me to testify, you asked me to speak to three issues:

-- the nature and magnitude of the problems in mathematics, science, and foreign language education;

-- the appropriate response to these problems at various levels of government, and by the private sector;

-- the appropriate Federal legislative response.

I will comment briefly on each of these in turn.

The Nature and Magnitude of the Problems in Mathematics, Science, and Foreign Language Education

From various studies and reports members of the Subcommittee are undoubtedly familiar with certain facts that bear on the problem under review today. For example, we know that:

-- Only 15 percent of American high school students now study a foreign language, down from 34 percent in 1965;

-- Only 8 percent of American colleges and universities now require foreign language for admission, compared with 34 percent in 1966;

-- Only one-third of the nation's 17,000 school districts require more than one year of mathematics and science for graduation;

- -- Mathematics scores of 17-year olds declined significantly in two national assessments of mathematics (1973, 1978);
- -- In 1981, 50 percent of teachers newly employed nationwide to teach secondary science and mathematics were actually uncertified to teach those subjects;
- -- Remedial mathematics enrollments at 4-year colleges and universities increased 72 percent between 1975 and 1980 -- compared to a 7 percent increase in total student enrollments for the same period;
- -- Industry, business, and the military commonly report that new employees and recruits lack the competence for a broad range of increasingly technical jobs.
- -- The number of high school students taking calculus in the USSR has reached 5 million. For the United States the comparable number in 1977 was 105,000.
- -- On a per capita basis (for the relevant age group) for each engineering graduate produced per year in the United States, the United Kingdom produces 1.1 engineers, West Germany produces 1.4 engineers, Japan produces 2.6 engineers, and the USSR produces 4.1 engineers.

These facts make clear the existence of a problem, but they do not expose the full range and depth of the problem we confront and how difficult solutions will be. Let me comment on just a few.

Teacher shortage. We know from the statistical evidence that there is a critical shortage of secondary school teachers in mathematics and science; we also know by the same evidence that there is a somewhat smaller shortage of foreign language teachers. However, these figures disguise the real magnitude of the problem. For example, Indiana is one state that currently reports a shortage of math and science teachers; it is also a state that requires only one year of mathematics and one year of science for high school graduation. If the Indiana Department of Public Instruction doubles the math and science credits required for high school graduation, as is presently planned, the problem will worsen immediately. In 1982 Indiana's four major state universities graduated sufficient mathematics teachers to fill only 58% of the vacancies listed in Indiana schools. In 1982 these four universities graduated a total of three people in chemistry, four in earth science, four in general science, and two in physics who were qualified to teach these subjects in Indiana secondary schools. Some high schools no longer even offer physics or advanced courses in foreign language. (It is not necessary to list a teacher shortage if you have dropped the course.) The statistics about our shortages are grim; but they do not reveal how truly serious the problem is. In part, schools now manage the problem of teacher shortage by dropping the courses.

Student Interest and Competence in Mathematics, Science, and Foreign Languages. Most of the facts presented to us deal with declines in high school student performance on standardized examinations, the low rates of student participation in secondary school courses, and the growth in remedial courses in college. But the problem begins earlier than the facts suggest. Students have little opportunity to study mathematics, science, and foreign language in the elementary grades, where such subjects typically begin in other nations. The result is that our students acquire fears or phobias toward these subjects before they reach secondary schools. Attitudes are set early. Few students choose a career involving math, science, or foreign language in college if they have not acquired a sound background in these subjects in junior high and senior high school. Most of our elementary school teachers have little background in these subjects and tend to give them less importance. We shall not solve the problem of inadequate science, mathematics, and foreign language instruction until we begin to have a greater impact on instruction in the elementary schools as it relates to these subject areas. Yet, consider the magnitude of retraining more than 1½ million elementary school teachers.

Worker Competence. Much attention has been directed to such issues as inadequate preparation for college, shortages of engineers, and other problems affecting the best educated of our population. Too little attention, in my view, has been devoted to the mathematics, science, and technology competence that will be required of all Americans. The fact is that the kind of education that everyone will need to participate in an increasingly scientific, technological, globally-interconnected, information-processing, service-oriented society is not the same education we deemed sufficient in the past. The ability of our schools and colleges to help us through a period of rapid transformation of the workplace will likely prove decisive for the economic future of our society. Currently 20 million workers, 20 percent of the labor force, are employed in blue collar manufacturing. By 2005 it has been estimated that only seven to twelve million workers, or five to ten percent of the work force, will be engaged in blue collar manufacturing jobs. The decline in birth rates, the need for greater worker productivity in order to make our products more competitive with those of other nations, and the appearance of entirely new products and services will force curriculum changes on the schools.

Following is a list of jobs that are forecast to be available in 1990.* Many of these jobs did not even exist ten years ago. Consider their implications for science, mathematics, and education in technology.

Industrial Laser Process Technician -- 2,500,000 jobs
Industrial Robot Production Technician -- 1,500,000 jobs
Materials Utilization Technician -- 500,000 jobs
Genetic Engineering Technician -- 150,000 jobs
Holographic Inspection Specialist -- 200,000 jobs
Battery Technician -- 250,000 jobs
Paramedic -- 1,300,000 jobs
Geriatric Social Worker -- 1,000,000 jobs

It is not likely that the schools and colleges can provide all of the particular technical skills such workers will require. But industries will demand greater entry-level performance in all of the basic skills, if workers are to acquire the technical skills needed. In short, schools must educate to new levels of "literacy" that include: math literacy, science literacy, computer literacy, and ability to read technical manuals and other materials appropriate to the job.

For the past 15 to 20 years, we have asked the public schools to pursue two main goals: increase access to schooling and equalize opportunity for all groups in our society. By these criteria the schools have been remarkably successful. We provide formal schooling for more full-time students than do most other Western nations. More than 75 percent of American youth ages 15-19 are full-time students; comparable percentages for youth of the same age are 51 percent for France and Germany, 44 percent for Great Britain, and 40 percent for Italy. We have also shown progress in equalizing opportunity for all Americans, regardless of race, social class, or ethnic identity. Thirty years ago approximately 55 percent of white students graduated from high school whereas only 30 percent of black students graduated. Today, 85 percent of white students and 75 percent of black students complete high school. We do not want to lose these gains, but now we must ask whether the kind of schooling we are providing is sufficient. It is not enough merely to complete high school or attend a college. Education must be closely geared to the kind of society in which young people will live and the kinds of careers they will have. It should be obvious that there is a considerable gap between what the schools provide now and what they must be able to offer in the future.

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*Marvin Cetron and Thomas O'Toole. "Careers with a Future: Where the Jobs Will Be in the 1990's." The Futurist (June, 1982) 14-15.

The Appropriate Response to these Problems at Various Levels of Government, and by the Private Sector

The effort to bring about changes in schooling so as to provide a proper education for Americans now and in the future will require cooperation among all levels of government -- local, state, and Federal -- and with the private sector. I wish to postpone my comments on the Federal role until the last section of this paper. And rather than offer general comments about what state and local governments can do in collaboration with the private sector, I should like to report briefly on some efforts underway in Indiana.

First of all, it should be noted that Indiana -- like its sister Great Lakes states -- has been hit hard by the recent recession. Unemployment in

January was 13.8 percent; in some cities such as Kokomo, Anderson, and Fort Wayne, unemployment has been hovering near 20 percent. In spite of this problem -- or perhaps even because of it -- Indiana's political and business leaders have decided that Hoosiers should devote more attention to their schools. Approximately one year ago, the Governor, with the advice and support of the General Assembly, appointed a Select Advisory Commission for Primary and Secondary Education; Commission members include representatives from both Houses and both political parties of the General Assembly and lay people drawn from communities across the state. They have submitted a preliminary report whose recommendations have already taken the form of legislation; a final report is due within a year.

Last summer and fall, a group of scientists, mathematicians, and educators at Indiana University held discussions on what could be done to advance the cause of science and mathematics instruction in the state of Indiana. One result of their discussions was a state-wide conference held on October 19, 1982 on the Bloomington campus of Indiana University. More than 300 persons from all sections of the state attended the meeting to hear leaders from government, business, labor, higher education, and the public schools express their concern about the status of science and mathematics instruction and what should be done about it. (A copy of the conference report is attached to this testimony.) At the end of the conference the participants approved a set of recommendations aimed at strengthening math and science instruction in our state. Many of these recommendations have subsequently been adopted by relevant groups.

Finally, a group of lay leaders and educators from all parts of the state will convene the first Congress on Education in Indiana on June 7, 1983. It is expected that 500 or so people, each a leader in his or her own region of the state, will meet to plan an educational agenda for the remainder of the decade. The Congress has the full support of the private sector and the various professional associations representing teachers, school boards, school administrators and others. Indiana citizens realize that the long-term economic health of their state rests upon the strength of the educational system, and they have initiated a series of steps that will produce results.

More concretely, here are a few things that have been achieved to date as a result of the Commission, the state-wide conference on science and mathematics, and other forms of collaboration.

-- The Department of Public Instruction has proposed the first major changes in high school graduation requirements in 50 years. These changes include raising the number of total credits needed from 32 to 38, doubling the number of required mathematics and science courses from one year each to two years each, and adding a computer competency requirement.

-- The General Assembly is currently considering and is expected to approve legislation that:

  -- Will provide forgiveable loans to people electing to enter teaching fields where there are "critical shortages." At the present time this is mainly mathematics and science;

  -- Will provide fellowships for currently certified teachers in other subject fields who wish to return to college to take courses leading to math and/or science teaching certification.

- -- Will provide tax incentives for businesses that employ math and science teachers during the summer months;
- -- Will enable school systems to purchase computer hardware and software;
- -- Will establish a state-wide clearinghouse of information on instructional uses of computer hardware and software;
- -- Will equip and staff 10 training sites throughout the state where elementary and secondary school teachers can receive training in the instructional use of microcomputers. Funds will make it possible for 10,000 teachers to receive training during the next two years.

-- The Lilly Endowment has established a program of "linkage" grants that encourage university-school cooperation according to problems confronting schools. Many of the projects will deal with efforts to improve instruction in mathematics and science and the use of technology.

-- The Indianapolis Public Schools, the Indianapolis Chamber of Commerce, and local businesses and industries have established a "partners" program that brings working scientists and engineers into close collaboration with the schools, including donations of time in which skilled engineers and technicians provide classroom instruction without cost to the school system.

-- Indiana University has recently established the Office of School Programs that is engaged in a wide range of activities designed to link the University more closely to schools throughout the state.

Behind these very specific actions lies a spirit of cooperation linking state and local government, the professional associations, and the business community in ways not typical of the past. There is a growing awareness that the economic/social health of the state is bound up with the quality of education provided Indiana youth. All have a stake in helping it improve.

If Indiana is typical of other states, then Congress should pay careful attention to what is already underway so as to make the best use of Federal resources and to avoid duplication and redundancy. With so few funds available, it is important that state and Federal efforts complement each other.

The Appropriate Federal Legislative Response

In the United States public education is generally understood to be primarily a responsibility for state and local governments. Nevertheless, some educational issues are matters of national concern and demand a Federal response. During the past 25 years we have gained considerable experience in ways that the Federal government can contribute importantly to advancing education without eroding state and local authority.

I know that you will be considering a number of legislative initiatives. I have reviewed H. R. 1699 "The Emergency Mathematics and Science Education Act" and S. 530 "Education for Economic Security Act," two of the bills you will consider and find much in them to recommend. With regard to S. 530 I was pleased to note in Section 7 that vocational education has not been ignored. I hope that as the Committee continues to consider this section it will give special attention to the need to strengthen the basic skills components of vocational education. In Indiana and in many other states that are increasing high school graduation requirements, it will be students in vocational education, more than those expecting to attend colleges and universities, who will be most affected. As states strengthen requirements in mathematics and science, it is vital that some of the new courses be closely linked to the needs of vocational education. I was also pleased to note that Section 8 of S. 530 includes a reference to "employment-based programs." It is important that colleges and universities be stimulated to devote greater attention and resources to helping prepare those who will direct worker training and retraining programs and to devise new kinds of instructional materials for facilitating employee training.

While the approaches vary somewhat between the two bills, both H. R. 1699 and S. 530 offer means to correct current teacher shortages in mathematics, science, foreign language, and computer technology. These are positive efforts and deserve to be encouraged. Loans, fellowships, teacher institutes, etc. can attract new people into the teaching field and retain those who are currently employed. Yet, we should be modest in our expectations regarding what can be accomplished by depending solely upon these solutions. The main reason that we have a shortage of mathematics, science, and foreign language teachers is that in order to teach these subjects it is necessary for a person to undergo extensive training; they are demanding subjects to teach; and teachers of these subjects can find jobs outside of education that pay much higher salaries than they can earn as teachers. We have let the market mechanism operate to reduce the number of people entering the teaching profession. By depressing the salaries of teachers, we have driven away many of our best teachers, the most ambitious, those who can command higher salaries in the private sector. Until we confront this problem head on, we shall be unable to resolve the teacher shortage problem in a fully satisfactory way.

I also worry about the possible overlap and duplication of Federal programs with state programs. As I have indicated, Indiana has launched a program of forgiveable loans and fellowships to entice people into critical shortage teaching areas. If other states are doing the same, there will be less need for this kind of effort by the Federal government. Frankly, I also worry about dribbling out relatively small sums of money over a great many institutions, leaving too little at any single place to do much good.

Therefore, I have tried to think of tasks that only the Federal government can do, that won't or can't be undertaken by any state acting alone. One such task is the establishment of four or five model demonstration centers that would possess sufficient resources that they could possess and demonstrate state-of-the-art technology for instruction and that could develop, evaluate, and disseminate instructional materials aimed at improving instruction in science, mathematics, foreign language, and computer education wherever such instruction is needed: elementary and secondary schools, teacher education, employment-based training programs, etc. Such centers could be located on university campuses where cooperation between scientists, mathematicians, language experts, and teacher educators already exists. The model centers ought to be established as partnerships that involve the university, school authorities, and representatives of business and industry. Federal funds might be matched with money or in-kind contributions from the various "partners."

It is also important for Congress to recognize that most schools, colleges, and departments of education that would be asked to host programs to train or retrain teachers in mathematics, science, foreign language, and computer education are themselves under supported and poorly equipped for this responsibility. Perhaps a majority of science education laboratories used to prepare science teachers are out-of-date; most teacher education institutions lack fully operative microcomputer labs and the ability to employ faculty for leadership in instructional computing. There are enormous differences across the 1300 or so sites where teacher education occurs in our nation, but relatively few are currently equipped or appropriately staffed to meet their responsibility.

And finally, Congress should be concerned about the problem of productivity in education just as it is concerned with the level of productivity in the economy as a whole. It will be necessary to find more efficient and less costly means to deliver high quality instruction in new fields to all who need it. This will require making better instructional use of existing and forthcoming technologies including interactive cable television and home computers equipped with videodiscs. You should not expect that the states or local educational authorities can mount research and development efforts in the use of advanced technology, but the Federal government and private industry working together could blaze new paths. These are some of the ways that Federal investments could truly make a difference.

In Conclusion

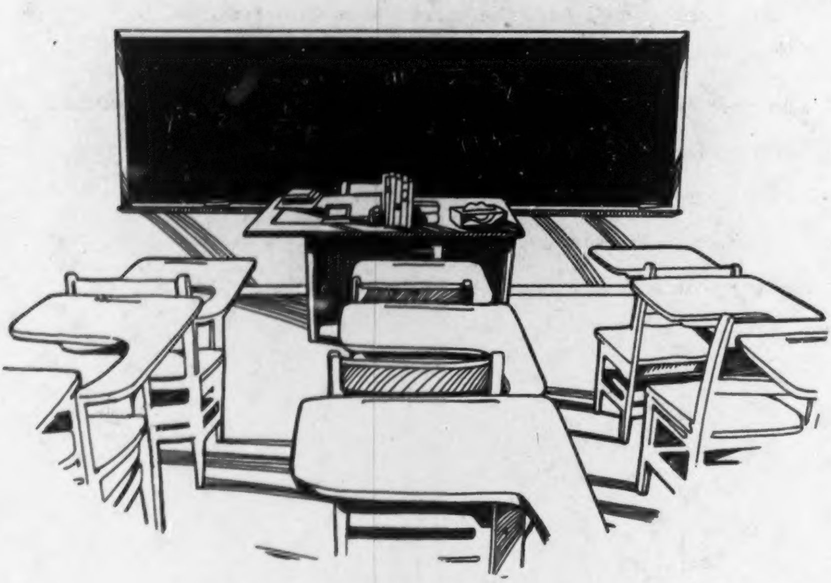
Mr. Chairman: I am reminded of a quotation from Act IV, Scene 3 of Julius Caesar in which the actor states:

"There is a tide in the affairs of men
Which, taken at the flood, leads on to fortune;
Omitted, all the voyage of their life
Is bound in shallows and miseries.
On such a full sea are we now afloat,
And we must take the current when it serves,
Or lose our ventures."

I believe American education is at such a flood-tide now. Americans are aware that action is required to improve schooling if our country is to move forward and to retain its leadership position in the world.

I am grateful for the opportunity you have given me to address the Subcommittee this morning. I am optimistic about the fruits of your deliberations.

Facing the Crisis of Mathematics and Science Education in Indiana Elementary and Secondary Schools



Report of the Conference
Sponsored by
The College of Arts and Sciences
and
The School of Education
Indiana University
Bloomington, Indiana
October 19, 1982

On October 19, 1982, more than 300 persons from throughout Indiana met on the Bloomington campus of Indiana University to discuss a crisis facing the state: the decline of mathematics and science education in the elementary and secondary schools.

Participants at this conference came from a variety of occupations. Business, industry and labor leaders were there. Representatives from Indiana's legislative and executive branches participated. Scientists from Indiana's industries and research institutions were there, as were science, mathematics and education professors from more than 23 colleges and universities. Teachers and administrators from many of the state's school systems also participated.

All of the participants agreed that the decline of mathematics and science education is a crisis affecting everyone in the state, but this was not just a convention to recognize that a problem exists. It was a working conference to determine possible solutions to this problem, solutions that would work for Indiana.

Because the problem affects all sectors of society, a concerted effort by all sectors is needed for a solution. Business and industry must combine with government and education to combat the deterioration of science and mathematics education in Indiana. The participants at this conference stressed this need for cooperation and discussed a number of ways in which the separate sectors could work together.

The conference was organized into four panels to ensure generating specific inputs from each sector. Leaders from business, industry and labor comprised the first panel and reported on the specific effects this crisis has on the state's economy and how they are dealing with the problem. The second panel included leaders from Indiana's government who discussed the initiatives that could come from that sector and the problems they face in taking action against the crisis.

The third panel included teachers and school administrators from the state. Because any action taken to improve the quality of mathematics and science education will necessarily involve the state's educators, these panelists emphasized ways in which Indiana's educators could be helped in their efforts to teach the state's youth, as well as ways in which more qualified teachers could be attracted into the profession.

The fourth and last panel included representatives from the state's universities and technical colleges. It is these institutions that supply many of the skilled workers for the state and almost all of the state's teachers. If Indiana is to ensure enough skilled workers and qualified mathematics and science teachers to meet its needs, then these institutions must be helped in their work.

This conference was only the first step in dealing with the crisis. Awareness of the problem was increased and possible actions were proposed. But any real solutions to the crisis will require the continued efforts of all involved. It is hoped that strong and effective actions be taken soon, and that all sectors of Indiana will work together until the problem is solved.

Impetus for this conference came from a committee of educators at Indiana University who are greatly concerned about the decline of mathematics and science education in Indiana. The conference was organized by this committee and sponsored by the College of Arts and Sciences and the School of Education at Indiana University and was funded by the Lilly Endowment, Inc., and the Indiana Universtiy Foundation. Publication of this report was made possible through the generous support of the Delco Electronics Division of General Motors Corporation.

Facing the Crisis of Mathematics and Science Education in Indiana Elementary and Secondary Schools

Business, Industry and Labor Perspectives on the Crisis

- Bert Curry, Executive Director of Personnel, Eli Lilly and Company
- John Walls, President, Indiana State Chamber of Commerce
- Max Wright, Secretary Treasurer, Indiana State AFL/CIO
- Frank Jaumot, Director of Advanced Engineering, Delco Electronics Division, GMC
- Carole Garstang, Vice President, Indianapolis Chamber of Commerce

Government Perspectives on the Crisis

- John M. Mutz, Lieutenant Governor, State of Indiana
- Marilyn Schultz, Member, House of Representatives, Indiana General Assembly
- Harold Negley, State Superintendent of Public Instruction

Public Schools Perspectives on the Crisis

- Cordell Affeldt, President, Indiana State Teachers Association
- Alfred L. Bias, Principal, Elkhart Central High School
- William Lumbley, Chemistry Teacher, Bloomington High School South

Higher Education Perspectives on the Crisis

- Allan H. Clark, Dean, School of Science, Purdue University
- H. Victor Baldi, Vice President, Indiana Vocational and Technical College
- F. Keith Ault, Professor of Chemistry, Ball State University

Summary and Recommendations

Introductory Remarks

George Springer, professor of mathematics, Indiana University

Because Indiana's economy has been closely linked to the production of automobiles and steel, this state has been one of the hardest hit by the current economic malaise. There has been a general recognition in the state of the need to compete with the other 49 states for new industries to shore up our economy and provide new employment opportunities. But the same needs have been recognized in every other state, and the competition will be fierce.

In selecting sites for locating business or industry, the available work force is an essential factor, and the new high-technology industries require both better trained and better educated personnel. Richard Stoner, vice chairman of the Board of Directors of Cummins Engine Company, has written that "Educational climate is the number one factor Cummins considers in locating new plants. This has been confirmed repeatedly by people seeking new industries for Indiana."

What is Indiana doing to prepare its children for the new work force that requires some level of scientific literacy and mathematical skill for almost all of its employees?

While Indiana had 2.38% of the total U.S. population in 1979, it had only 1.68% of the U.S. citizens who had completed four years of college—the lowest percentage of the 15 largest states in the nation and well below the national average.

Indiana has three persons with less than four years of high school for every person with four or more years of college. Compare our statistics with those for states such as Illinois or Missouri which have two people with less than four years of high school for every person with four or more years of college, or to those for states such as California and Massachusetts which have one person with less than four years of high school for every person with four or more years of college.

Sputnik shook everybody up because it was something our enemies did that we could see. But this is a quiet crisis and a lot of people don't believe in it. They need to be informed.—*Robert Jentgens, Crane Naval Weapons Station*

In the past, students easily succumbed to the temptation to drop out of high school and take jobs as unskilled laborers. We must now convince students to stay in school and train for the more demanding jobs that may be the only ones available for them when they enter the job market.

Are students responding to the demands of the job market? Data indicate that fewer Indiana students are now studying mathematics and science beyond ninth grade than a decade ago. There has even been an 18% decline since 1972 in the number of students taking algebra (compared to an 11% decline in total enrollment in Indiana public secondary schools during the same period), and we must remember that algebra is the key subject for further study in mathematics or science.

And how are we showing our determination to improve our educational programs? We allow ourselves to rank 34th in the nation and last among Midwestern states in terms of per pupil expenditures for education!

At the same time that the state is facing a need for a population that is better educated in science and mathematics, it is facing a critical shortage of secondary school mathematics and physics teachers and a shortage of chemistry, earth science and general science teachers. In 1982, Indiana's four major state universities graduated only enough mathematics teachers to fill 58% of the teaching vacancies. Even more shocking are statistics indicating that in 1982 these same four universities graduated a total of 3 chemistry students, 4 earth science students, 4 general science students, and 2 physics students with qualifaications to teach in these areas. Moreover, several (if not all) of these graduates probably chose not to take teaching positions because of the inability of school systems to offer salaries anywhere nearly competitive with those that business and industry can offer to people with their training in science or mathematics.

The states and the private sector must now assume a greater role in seeking ways of improving education. We have convened this conference to provide a forum for the three major constituencies—the private sector, state government, and the educational sector—to give their perspectives of the problem and propose ways that each can act, individually or cooperatively, to provide the improved educational climate Indiana needs so badly. Too much is at stake in this effort to even contemplate failure.

Business, Industry, and Labor Perspectives on the Crisis

Education has become an economic necessity, and many recent reports have emphasized that the economic structure of a community depends on its investment in education. As states increasingly compete for new businesses, especially high-technology industries, the availability of a well-educated work force has become a crucial factor for economic survival.

Bert Curry, the executive director of personnel operations for Eli Lilly and Company explained that his company relies heavily on Indiana's schools to provide the workers Lilly needs. Out of about 3,300 persons working for Lilly in research and development activities, two-thirds are technicians who do not hold degrees, Curry said. Therefore, Lilly encourages prospective employees to take as much high school mathematics and science as possible.

The day is past when parents could say to their child, 'just get your diploma and everything will be all right.' —*Max Wright*

John Walls, president of the Indiana State Chamber of Commerce, suggested that there are three options available for alleviating the shortage of qualified mathematics and science teachers. These include doing nothing, which Indiana simply can not afford; paying all teachers more, which is economically impossible; and finding a way to pay teachers in heavy demand areas more than those in areas of oversupply. The third option, Walls argued, is the only one feasible.

Indiana's unions are also greatly concerned about the quality of mathematics and science education because there is no longer a need for workers who do not understand mathematics and science, *Max Wright*, secretary treasurer of the Indiana AFL/CIO, explained. He added that in union apprenticeship programs for construction workers, machinists and other occupations, a good understanding of mathematics and science is essential.

The AFL/CIO therefore has a number of recommendations for improving mathematics and science education, Wright said. These include (1) encouraging students with talent in mathematics and science to continue studying these subjects beyond high school, (2) making school counselors more aware of job opportunities and their mathematics and science requirements, (3) setting up scholarship funds to encourage students talented in mathematics and science, (4) bringing teacher salaries more into line with salaries for other professions, and (5) making funds available for continuing education for teachers to help keep them up-to-date.

"The current and growing shortage of math and science teachers, and particularly good ones, is occurring for the same reasons that students are not taking math or science: lack of incentives," *Dr. Frank Jaumot*, the director of advanced engineering for the Delco Electronics Division of GMC, argued.

"In industry we know that both the price and volume of a product are determined by the marketplace if one wants to compete," Jaumot said. "If it means paying science and math teachers more, whether directly or indirectly, so be it. If it means providing them with better equipment than the home economics teacher, so be it."

Jaumot argued that Indiana should concentrate the training of mathematics and science teachers in a very limited number of institutions and also require that teachers take a reasonable amount of continuing education. He also said that more units of mathematics and science should be required for students, even at the expense of units on sex education, drugs and alcohol, nutrition and energy conservation.

Carole Garstang, vice president for the Indianapolis Chamber of Commerce, emphasized that partnerships linking business, industry and the schools are necessary both for raising students' aspirations and interest levels in mathematics and science, and for raising teachers' awareness of the use of mathematics and science in the real world.

All the panelists agreed that the economic well-being of the state depends on the well-being of our schools. Several of the panelists suggested that differential pay for mathematics and science teachers may be desirable but, by itself, will not solve the problem. Other incentives are needed as well. All the panelists agreed that a closer alliance between business, industry and the schools is necessary.

Government Perspectives on the Crisis

The need for the state government to be involved in any effort to improve mathematics and science education in Indiana's elementary and secondary schools should be obvious. The state is responsible for providing funds to operate the schools, for licensing the teachers and for establishing the minimum requirements for graduation.

Indiana Lt. Gov. John Mutz said that the state needs to spend more money for education, although the governor's policy for the past two years has been not to raise taxes despite increasing requests for money from the state's school corporations.

"The kind of commitment government needs to make is the one that reflects the importance of education in the future," he said. "Additional investments in the future of this state are essential."

If we could get our superintendents and principals to put as much effort into finding qualified math and science teachers as they put into finding coaches, I think we would have part of our problem solved.—*Marilyn Schultz*

Mutz, who is also director of the State Department of Commerce, explained that available jobs, and the kind of training that will be required for these jobs, are likely to change dramatically in the next 10 to 15 years.

"The economic analysis section of our department is determining what we call 'the targeted industries' for the future in Indiana. They are significant in terms of why mathematics and science, foreign language, and computer literacy and those related subjects are important areas for concern in terms of our educational system," Mutz said. He explained that these targeted industries are the communications/electronics industry; the diesel engine industry; the materials industry, including the production of steel and aluminum; and the energy industry, all of which will require a work force knowledgeable in mathematics and science. He added that even the agricultural industry, with the use of the new recombinant DNA technology, will require a highly skilled work force.

Marilyn Schultz, the state representative from Bloomington, agreed that Indiana needs more money for basic education programs in the elementary and secondary schools, as well as a substantial investment in equipment, including computers, for the schools. But money is just the starting point, she said. Some of the options Schultz suggested for recruiting more mathematics and science teachers were forgiving student loans for those entering teaching in critical shortage areas, state-funded retraining of teachers, putting emphasis on part-time teaching to allow graduate students and retired scientists to teach, state-supported summer programs for students and teachers, offering teachers summer jobs with business and industry, and giving teachers more career opportunities by offering them 12-month contracts.

Schultz, who is a member of the Governor's Select Commission on Primary and Secondary Education, also said that stress and criticism should be applied to school administrators who allow and foster unqualified personnel in the classrooms.

"I have heard case after case of qualified science and math teachers waiting to fill a vacancy until after the coaching position was filled, because the highest priority in that high school or middle school was getting a football coach who could if necessary teach math, whether or not qualified, rather than getting that math teacher in," Schultz said.

But as bad as the teacher shortage is, the shortage should be even greater, *Harold Negley*, the state superintendent of public instruction, explained.

"The real shortage is that there wasn't a group of youngsters out there who were pressing, and whose counselors were pressing them, to cause a shortage of teachers," Negley said. He added that if students were taking as much mathematics and science as they need, the teacher shortage would be much greater than it currently is.

Negley pointed out that a grassroots movement for more science and math education has begun, but that more leadership from school administrators is necessary. He added that the Commission onGeneral Education, which he chairs, will be pushing to raise the minimum requirements for mathematics and science in the schools.

Public Schools Perspectives on the Crisis

Whatever initiatives are eventually taken to solve the problems in mathematics and science education, Indiana's teachers will be a central factor for their success. But the supply of teachers is dwindling steadily. In Indiana, only about one-third as many persons entered teaching last year as a decade ago. Furthermore, 10% of the teachers under 40 years old recently responded to an Indiana State Teachers Association poll by saying they definitely plan to quit teaching as soon as possible, and another 62% said they plan to leave but either had not decided when or were waiting for something better to come along. Clearly, if a solution to the problems of mathematics and science education is to be found, then teachers' concerns must be taken into account.

Cordell Affeldt, the president of the Indiana State Teachers Association and an elementary school teacher, emphasized that problems causing the shortage of mathematics and science teachers are also causing shortages of teachers in many other areas. Furthermore, these problems are likely to become much worse in the next decade, Affeldt said, adding that the use of quick fixes, such as "bounty pay" (paying higher salaries to teachers of particular subjects) and the use of unqualified personnel in the classroom, is simply shortsighted and will not solve the basic problem.

In education, it seems at times that it is forgotten that our final 'product' is a vital piece of humanity.—*William Lumbley*

William Lumbley, a chemistry teacher at Bloomington High School South, agreed that the salaries of science and mathematics teachers should not be raised above those of other teachers. While inadequate salaries are a malignancy that continues to drive teachers from the profession, Lumbley pointed out that there are many other problems affecting teachers. He added that because of these problems, he can not counsel a talented student to enter teaching.

"I could not, in good conscience, try to convince them to enter a field where the pay is half of what they could receive in the private sector with the same background, where the pressures of 'accountability' are not based upon what you do and how well you do it but rather on hearsay and personality conflict, where your product is never publicized and seldom returns to say 'Thank you,' or where the hours that are necessary to adequately prepare for the next day detract from the care and attention of your own family members and their needs," Lumbley explained.

Lumbley stated that the conditions under which mathematics and science teachers work must be improved. Some of Lumbley's recommendations include "that no science laboratory course be conducted with more students enrolled than there are safe, functioning laboratory stations available . . . that the science teacher be given the same consideration in time and budget for preparing and maintaining curricular activities as others are for extracurricular activities," and "that active support and observational basis for that support create an awareness in the decision makers, the policy formulators and the general public that the work of the science teacher is not simply an amoeboid motion nor a puff of smoke."

Alfred L. Bias, the principal of Elkhart Central High School, agreed that salaries and working conditions must be improved, and added that the image of teaching as a career should also be promoted both in the schools and universities and among the general public. "Teachers want to be appropriately paid and appropriately respected," Bias said.

There are pressures now at work that are likely to intensify all shortages in the future.—*Cordell Affeldt*

All of the panelists agreed that the problems affecting mathematics and science teachers also affect all teachers. They emphasized that a commitment to quality education from the state is desperately needed, not only in terms of higher salaries but also for regular, funded inservice training and continuing education for teachers. They also suggested that teacher/professor exchanges, summer employment programs for teachers in business and industry, and forgiveable loans for education students be established as soon as possible.

They find a warm body to slip into a classroom somewhere and turn off the kids, which is virtually what happens from day one.—*F. Keith Ault*

Higher Education Perspectives on the Crisis

One of the major resources available for combating the crisis in mathematics and science education is the state's universities and technical colleges. It is in these institutions that Indiana's teachers and skilled workers are trained. These institutions also hold a large pool of scientists and educators who can be tapped to help retrain teachers that are already in the classrooms, as well as providing the expertise needed to design the programs and curricula that will be needed if the crisis is to be solved.

"I think we have come to the time where we must look for a revision of the state tax structure," *Allan H. Clark*, the dean of the School of Science at Purdue University, told the conference participants. "The property tax freeze, the fact that we are very low in income tax and in sales tax, simply means that we do not have the resources to do what needs to be done and to make the improvements that need to be done."

Because Indiana's teacher shortages are severe, the state needs to move faster than other states to solve the problem, Clark said. Incentives for elementary and secondary school teachers should be increased, and the National Science Foundation Summer Institutes for teachers, which ended eight years ago in the summer of 1974, should be reinstituted, he added.

Clark recommended that national standards should be set for elementary and secondary school curricula in mathematics and science: "Not accreditation, not a huge system of boards investigating school districts, but publish what the curriculum should be and how many years of chemistry, physics and mathematics students should have to prepare for various college opportunities."

H. Victor Baldi, vice president of Indiana Vocational and Technical College, said that many high school graduates have insufficient backgrounds in mathematics to be successful in post secondary education, including vocational training. Because of this, IVTC and other two-year institutions have to place tremendous emphasis on remediation and developmental studies.

Money will not solve all the problems . . . but certainly, this is one problem that wouldn't be hurt by having some money thrown at it.—*Allan H. Clark*

"Before the student can get down to the business of studying whatever he or she came to study, there has to be some effort to provide them with the basic skills to be successful enough in a particular program," Bladi explained, adding that the inability to handle mathematics is one of the major reasons why students drop out of their courses.

Baldi said that mathematics is particularly important because all courses require mathematics skills. He gave as an example a recent state-wide curriculum meeting concerning their welding program. Baldi said that welding instructors wanted two math courses for their students but he thought that one would be enough: "because, after all, it's just a welding course. Until the welders told me, 'Well, all right. We'll go for one math course provided you get the trig functions in the first mathematics course.'"

Many Indiana colleges have to focus on remedial education to supply skills that should have been learned in high school, Baldi said. "I do not think that there is a sufficient amount of math, or science, or a few other meaningful subjects being required of students. In fact, the graduation requirements seem to have reduced themselves to a minimum common denominator approach which, in my opinion, can only lead to mediocrity."

F. Keith Ault, a professor of chemistry at Ball State University, agreed that students are not learning enough mathematics and science, and suggested that part of the problem is the public's perception of the importance of these subjects.

"There is a school corporation within 20 miles of Muncie. I won't mention the name, but that school corporation two years ago had $75 for a science budget that was to be used by more than 300 students. That kind of effort on the part of the school administration is insidious," Ault said.

All of the panelists agreed that the state must increase funding for the schools if quality education is to be provided. It was repeatedly pointed out that Indiana must *at least* bring the funding for its educational institutions up to the national average.

Summary and Recommendations

The last segment of this conference on the crisis in mathematics and science education in Indiana's elementary and secondary schools included a discussion by all of those participating in the conference on recommendations for a solution. All of the participants had a chance to voice their opinions on each recommendation, and after much discussion the following recommendations were agreed on. These recommendations have been organized into categories based on where initiatives for action would originate.

A lot of people out there think their kids are getting a good education, that they are getting everything they need. They badly need to be informed.—*Robert Jentgens, Crane Naval Weapons Station*

Recommendations for State Government

1. The State Department of Public Instruction should establish a policy that all high school graduates will have studied mathematics and science for at least three years in grades 9-12. Students preparing to attend college should be urged to study four years of mathematics and science.

2. A program of "forgiveable" loans to college students preparing to teach mathematics or science should be established.

3. The governor should establish a commission on precollege mathematics and science composed of representatives from each of the four sectors represented at the conference.

4. A policy should be implemented that will ensure that elementary and middle/junior high school teachers are adequately prepared to teach mathematics and science.

5. State agencies should work with colleges and universities to identify ways to attract women and minorities into mathematics and science careers.

6. The state should support in-service institutes (especially summer institutes) for the continuing education of mathematics and science teachers. Such institutes should be funded jointly by support from state agencies and the private sector.

7. The state should begin a program to train retired persons with strong mathematics and science backgrounds who might be interested in part-time mathematics or science teaching.

8. The state should establish statewide educational goals and public policies for mathematics and science education, or at least support the development of an agenda for action in attacking the problem

Recommendations for School Systems

1. Both mathematics and science should be taught to all students during every year in grades K-8. School systems could hire mathematics and science consultants and resource teachers for the elementary grades to facilitate this.

2. School systems should hire only qualified teachers to teach mathematics and science in grades 6-12.

3. School systems should give priority in hiring teachers to applicants with relatively strong mathematics and science backgrounds, particularly elementary school applicants.

4. School systems should establish a policy of professional development incentives for teachers in critical shortage areas.

5. School systems should require all students to study about computers to the extent necessary to ensure computer literacy.

Recommendations for Colleges/Universities

1. College/university teacher educators should evaluate their mathematics and science teacher education programs with the goal of determining how to make them more attractive to prospective teachers and more relevant to the needs of practicing teachers.

2. College/university faculty should be more willing to go to schools as resource persons.

3. Colleges/universities that have summer institutes for talented mathematics and science students should hire selected high school teachers as adjunct faculty for these institutes.

4. College/university mathematics and science educators should find more ways to utilize computers as instructional devices in mathematics and science classrooms at all levels. They should also establish workshops for developing computer literacy.

5. Colleges/universities should raise their entrance requirements in mathematics and science.

6. Colleges/universities should actively recruit women and minorities into mathematics and science careers.

7. Colleges/universities should develop adult education programs in mathematics, science and computers.

8. College/university mathematics and science students should be encouraged to volunteer as part-time teachers in schools where mathematics and science teachers are needed. They should also serve as resource persons in elementary schools.

Recommendations for the Private Sector

1. Businesses/industries should provide part-time and summer employment for mathematics and science teachers.

2. Businesses/industries should assist state and local governments in providing low interest loans to students who are preparing for teaching careers in mathematics and science.

3. Businesses/industries should use their facilities for the development and recognition of teachers.

4. Businesses/industries should devise means to allow employees with strong mathematics and science backgrounds to teach mathematics or science part time in schools.

5. Businesses/industries should make available to schools and colleges information about career opportunities in mathematics and science-related areas.

6. Businesses/industries should help support the training of retired persons with strong mathematics and science backgrounds who might be interested in part-time mathematics or science teaching in the schools.

General Recommendations

1. The four sectors should work together to establish some consensus about the mathematical and scientific knowledge *all* students should acquire, both for high school graduation and college admission.

2. There should be a cooperative effort among the four sectors to determine attractive opportunities for continuing in-service education for mathematics and science teachers.

3. The four sectors should establish more mathematics and science teacher resource centers around the state.

4. The four sectors should work together to identify means for recognizing and rewarding outstanding performance both by teachers and students at every level.

5. All sectors should provide incentives to raise the prestige of mathematics and science teaching as a profession.

6. Government agencies, schools and colleges/universities should cooperate to retrain surplus teachers who have some aptitude, interest and background in mathematics or science. This would help alleviate the shortage of mathematics and science teachers.

7. Action needs to be taken to convince the public that improvements are necessary.

It is hoped that action will soon be taken on these recommendations, and that the current crisis in mathematics and science education in Indiana's elementary and secondary schools will be solved. The most important resource our nation has is its youth, and we are jeopardizing our future by neglecting our next generation.

If a coach loses a star player, that's news. If a teacher loses an entire program . . . that's too bad.—*William Lumbley*

Senator **Stafford**. Thank you very much, Doctor. Your help is appreciated.

Mr. Brod, you are next on the list, and we would be glad to hear from you.

Mr. **Brod**. Thank you, Mr. Chairman. My name is Richard Brod. I represent the Joint National Committee for Languages, a coalition of 25 organizations for professionals in languages and international studies.

In our view, language study has two basic functions in American education. One is in general education to give students of all ages a basic groundwork in language and culture. The other is specialized skill training, thorough training in the language and culture for those individuals who need proficiency in order to perform their work or their public duties, or who simply desire it for the enrichment of their private lives.

All forecasts lead us to believe that the demand for training and language skills will continue the slow rise that has recently begun. Americans seem finally to be coming around to realizing that our national deficiency in language competence has weakened us economically and in other ways.

Interest in language study is growing, and its value is coming to be recognized both by our leaders and by the public at large.

May I say parenthetically that I am happy to be here during Foreign Language Week. The week began on Monday. President Reagan issued a proclamation from which I would like to quote a few words: "We cannot afford to be complacent," he says, "about our position in the world community. Both our economy and our national security depend upon American competitiveness. We must be effective, not only in the development of high technology and telecommunications, but also in our ability to communicate in our own language, as well as the languages of other nations."

The two functions of language study, one general, one specialized, are different, but they are not incompatible. I am happy to say that there is good news on the front of language study in general education. After many years of what this morning was called permissiveness, colleges and universities have at last begun to restore the language requirements they abandoned 15 years ago.

Our most recent survey shows that 66 percent of them now have language requirements for the bachelor's degree, whereas about 5 years ago, the figure was only 54 percent. At the same time, our teaching profession has shown creativity in developing attractive and interesting new courses and in broadening the scope of curriculum in language and culture.

On the other hand, in specialized education and advanced research and training in language and area studies, the needs are growing; and it is clearly an area that the Federal Government must continue to address.

To quote a recently published statement on foreign language education by the Board of Regents of the State of New York: "Because foreign policy and international relations are the business of the Federal Government, this area almost uniquely is a clear province for Federal attention."

In the category of specialized education and advanced research and training in language and area studies, the Federal Government has made a major contribution through title VI of the Higher Education Act, originally known as the National Defense Education Act. These programs have a splendid track record, and in our opinion merit the continued recognition and support of the Congress.

Valuable as they are, however, they are also highly specialized and therefore limited in the number of people they can serve and in the kinds of institutions where they can be housed. To meet the growing economic, political, and cultural needs of our citizens for communicative skills in the use of foreign languages, programs of study in languages and cultures need to be made accessible to students of all ages in as many communities as possible. Incentives need to be found to encourage schools, colleges, and universities to invest their own resources into setting up programs in a variety of languages.

Incentives need to be found to encourage students, both in high school and in postsecondary education, to make the kind of commitment necessary for success, and above all, ways need to be found to insure an adequate supply of skilled teachers to meet anticipated needs and to retrain, refresh, and reequip experienced teachers to meet a growing demand.

Like the study of science, language study requires a considerable investment of time and effort. Like science teachers, teachers of foreign languages can easily grow rusty in their skills and have a legitimate need for refresher training at regular intervals.

As part of our own effort to build language competence in the Nation, leaders of our profession have recently embarked on a major effort to reach consensus on precise definitions of the stages of achievement in language study, ranging from novice level to survival skills, to the level of proficiency necessary for performing one's job.

The achievement of consensus in these definitions will not only help us become more accountable to our public, it will also enable us to shift the basis of educational measurement in our field from credit hours, that is, seat time, to proficiency. In other words, we will be able to certify what our students can do with a language, not merely how much time they have spent in the classroom. We are working on this, and the imminent, we hope, achievement of these definitions will, we think, usher in a quiet revolution in the teaching, study, and appreciation of foreign languages in the United States.

We believe that this particular change is in the national interest of the United States and that the kind of support and vision offered by such bills as S. 530 and H.R. 1310 will help us in accomplishing this goal.

I can assure the committee that our profession in turn is eager to make its contribution to helping the Nation prepare for the 21st century.

[The prepared statement of Mr. Brod follows:]

STATEMENT PRESENTED TO THE
SUBCOMMITTEE ON EDUCATION, ARTS & HUMANITIES
U.S. SENATE
March 9, 1983

Presented by:

Richard Brod

Director, Foreign Language Programs/Modern Language Association

Secretary-Treasurer, Joint National Committee for Languages

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THANK YOU, MR. CHAIRMAN, AND MEMBERS OF THE SUBCOMMITTEE, FOR THIS OPPORTUNITY TO REPRESENT THE MODERN LANGUAGE ASSOCIATION AND THE JOINT NATIONAL COMMITTEE FOR LANGUAGES IN ADDRESSING THE ROLE AND IMPORTANCE OF SECOND LANGUAGES TO OUR EDUCATIONAL SYSTEM AND OUR NATION. THE JOINT NATIONAL COMMITTEE FOR LANGUAGES IS AN ORGANIZATION THAT REPRESENTS TWENTY-FIVE OF THIS NATION'S MAJOR LANGUAGE ASSOCIATIONS. JNCL REPRESENTS THE INTERESTS OF OVER 200,000 PROFESSIONALS WITH EXPERTISE IN ALL AREAS OF THE LANGUAGE FIELD INCLUDING THE LESS COMMONLY TAUGHT LANGUAGES, THE CLASSICS, TRANSLATION, ENGLISH AS A SECOND LANGUAGE AND BILINGUAL EDUCATION. WE ALSO REPRESENT A NUMBER OF ASSOCIATIONS CONCERNED WITH THE RELATIONSHIP OF LANGUAGES TO TECHNOLOGY, SUCH AS THE INTERNATIONAL ASSOCIATION OF LEARNING LABORATORIES AND THE NATIONAL ASSOCIATION OF SELF-INSTRUCTIONAL LANGUAGE PROGRAMS. WE WISH TO TAKE THIS OPPORTUNITY TO EXPRESS OUR SINCERE CONCERN THAT LEGISLATION SUCH AS S. 530 IS NECESSARY AND TO STATE AGAIN OUR FUNDAMENTAL BELIEF IN LANGUAGE STUDY AS ESSENTIAL TO THE POLITICAL, ECONOMIC AND INTELLECTUAL SECURITY OF OUR NATION.

SINCE 1979, WHEN THE PERKINS COMMISSION DECLARED THE STATE OF FOREIGN LANGUAGE STUDY IN THE UNITED STATES "SCANDALOUS", THERE HAS BEEN A TENUOUS REVIVAL IN FOREIGN LANGUAGE STUDY. BUT THIS REVIVAL IS, AT THIS POINT, VERY SLIGHT AND VERY FRAGILE. IN ORDER TO CONTINUE TO ADDRESS OUR NATIONAL LANGUAGE INADEQUACIES, THERE MUST BE NATIONAL SUPPORT AND LEADERSHIP.

AT THE LOW POINT A FEW YEARS AGO, ONLY FIFTEEN PERCENT OF ALL UNITED STATES STUDENTS, FROM 7TH GRADE THROUGH GRADUATE SCHOOL, WERE ENROLLED IN THE STUDY OF A FOREIGN LANGUAGE. THAT FIGURE ITSELF WAS PROBABLY MISLEADINGLY OPTIMISTIC, SINCE ONLY THREE PERCENT OF THESE STUDENTS PURSUED A FOREIGN LANGUAGE BEYOND THE SECOND YEAR OF STUDY. ONLY EIGHT PERCENT OF THE COLLEGES OF THIS COUNTRY REQUIRED A FOREIGN LANGUAGE FOR ADMISSION. EVEN IN THOSE AREAS WHERE THERE WAS EVIDENCE OF INCREASED ENROLLMENTS, THE FIGURES WERE APPROXIMATELY 3,000 STUDENTS IN ARABIC, 10,000 IN CHINESE AND 11,000 STUDENTS IN JAPANESE, OUT OF A COLLEGE ENROLLMENT OF ALMOST 10 MILLION. THE MODERN LANGUAGE ASSOCIATION IS CURRENTLY IN THE PROCESS OF COMPILING THE DATA FOR THE LAST FEW YEARS, AND WE ANTICIPATE THAT WE WILL SEE AN INCREASED DEMAND FOR LANGUAGE STUDY ALTHOUGH THE NUMBERS WILL STILL BE HIGHLY INADEQUATE IN TERMS OF OUR NATIONAL NEEDS. IT IS NOTEWORTHY, AS WELL, THAT THE INCREASED DEMAND IS LARGELY IN THESE APTLY NAMED "LESS COMMONLY TAUGHT OR CRITICAL LANGUAGES" SUCH AS ARABIC, CHINESE AND JAPANESE.

THE SLIGHT INCREASE IN THE RECENT DEMAND FOR FOREIGN LANGUAGES HAS BEEN THE RESULT OF A NUMBER OF FACTORS: THE REPORT OF THE PERKINS COMMISSION (WE ANTICIPATE THAT THE CURRENT NATIONAL COMMISSION ON EXCELLENCE IN EDUCATION WILL CONTINUE THIS MOMENTUM WITH ITS FINDINGS WHEN ITS REPORT COMES OUT THIS MONTH AS WELL); THE PUBLICITY GENERATED BY ARTICLES IN BETTER HOMES AND GARDENS, READER'S

DIGEST, HARPERS AND SO FORTH; AND SOME NEW AND CREATIVE APPROACHES BY THE PROFESSION ITSELF SUCH AS COMPUTER ASSISTED INSTRUCTION.

WHILE THE SITUATION IN FOREIGN LANGUAGES IS, IN MANY RESPECTS, ANALOGOUS TO THE SITUATION IN MATH AND SCIENCE, THERE ARE ALSO PROBLEMS THAT ARE UNIQUE TO LANGUAGE TEACHING. IN SPITE OF THE CRITICAL NEED FOR THESE FIELDS, WE HAVE ALL SUFFERED DECLINES IN ENROLLMENTS AND AN EASING OF REQUIREMENTS. HOWEVER, THE LANGUAGE PROFESSION HAS NOT EXPERIENCED THE SEVERE TEACHER SHORTAGES OF MATH AND SCIENCE EXCEPT WITH REGARD TO THE CLASSICS, THE LESS COMMONLY TAUGHT LANGUAGES AND DUAL LANGUAGE ABILITIES. IN OTHER LANGUAGES, WE ARE EXPERIENCING "EMERGING SHORTAGES" AS THE RESULT OF INCREASING DEMAND AND REIMPLEMENTATION OF REQUIREMENTS. IN A RECENT NON-SCIENTIFIC SURVEY BY JNCL OF FOREIGN LANGUAGE SUPERVISORS IN TWELVE STATES, ELEVEN SPOKE OF "EMERGING" AND "SPOT" SHORTAGES. THESE SHORTAGES WILL BE EXACERBATED AS REQUIREMENTS ARE RE-INSTITUTED. FOR EXAMPLE, LAST YEAR SEVENTY COLLEGES AND UNIVERSITIES RE-INSTITUTED OR STRENGTHENED LANGUAGE REQUIREMENTS. AMONG THESE WERE SOME FAIRLY LARGE STATE UNIVERSITIES, SUCH AS THE UNIVERSITY OF CALIFORNIA, UNIVERSITY OF NORTH CAROLINA, UNIVERSITY OF NEW MEXICO, UNIVERSITY OF WASHINGTON AND UNIVERSITY OF VERMONT. THESE INCREASED OR STRENGTHENED ENTRANCE REQUIREMENTS WILL PUT CONSIDERABLE PRESSURE ON SECONDARY SCHOOLS TO FIND TEACHERS AND INCREASE COURSE OFFERINGS.

ANOTHER SLIGHT DISSIMILARITY FROM OTHER TEACHING

PROFESSIONS IS THE VITAL NEED FOR FOREIGN LANGUAGE TEACHERS TO HAVE PERIODIC RE-TRAINING IN BOTH SKILLS AND METHODS. IDEALLY, SUCH SKILL RE-TRAINING COULD BE DONE THROUGH AN OPPORTUNITY TO FUNCTION IN THE LANGUAGE IN ANOTHER COUNTRY, BUT IN MOST INSTANCES, IT MEANS WEEK-END OR WEEK LONG IMMERSION WORKSHOPS OR SUMMER INSTITUTES. METHODICALLY, AS THE DEMAND FOR COMMUNICATIVE SKILLS, SCIENTIFIC AND BUSINESS TERMINOLOGY AND PRACTICAL APPLICATIONS HAVE INCREASED, IT HAS MEANT THAT TEACHERS MUST KEEP UP WITH NEW METHODS AND HAVE AN OPPORTUNITY TO DEVELOP CREATIVE AND INNOVATIVE APPROACHES.

THUS FAR, I HAVE FOCUSED PRIMARILY ON THE NEED FOR LANGUAGE TEACHERS, THE REALITY IS THAT WE MUST ENCOURAGE INCREASED LANGUAGE STUDY FOR THOSE WHO DO NOT INTEND TO PURSUE CAREERS IN EDUCATION AS WELL. FOR EQUALLY IMPORTANT INTELLECTUAL, POLITICAL AND ECONOMIC REASONS, WE MUST PROVIDE LANGUAGE OPPORTUNITIES FOR OUR FUTURE BUSINESSMEN, DIPLOMATS, SOLDIERS, SOCIAL WORKERS AND OTHERS.

IN AN EDUCATIONAL SENSE, IT IS PARTICULARLY IMPORTANT THAT WE ENCOURAGE LANGUAGE STUDY IN ELEMENTARY AND SECONDARY SCHOOLS AS WELL AS IN POSTSECONDARY INSTITUTIONS. EXCLUDING THE OBVIOUS ACQUISITION OF CULTURAL AND LINGUISTIC KNOWLEDGE, ONE GOOD REASON IS THAT IT IS SIMPLY EASIER TO LEARN LANGUAGES AT A YOUNGER AGE AND THAT THOSE WHO LEARN LANGUAGES EARLY ARE MOST LIKELY TO CONTINUE WITH THE LANGUAGE AND HAVE AN EASIER TIME LEARNING OTHERS. SECONDLY, THERE IS CURRENT DATA TO INDICATE THAT SAT SCORES, BOTH

VERBAL AND MATH, ARE HIGHER FOR THOSE WHO HAVE STUDIED FOREIGN LANGUAGES. THIRD, THERE ARE STUDIES INDICATING THAT LANGUAGE STUDY IMPROVES READING SKILLS AND THAT READING SKILLS ARE TRANSFERABLE FROM ONE LANGUAGE TO ANOTHER. FINALLY, REAL LANGUAGE COMPETENCE, SUCH AS IS REQUIRED (OR SHOULD BE REQUIRED) IN DIPLOMACY AND INTELLIGENCE GATHERING, IS NOT ACHIEVED IN FOUR COURSES OVER TWO YEARS BUT RATHER REQUIRES YEARS OF STUDY.

IT IS FOR THIS LATTER REASON THAT LANGUAGE STUDY IN THE UNITED STATES SHOULD BE ADDRESSED IN A MUCH BROADER CONTEXT THAN JUST TEACHER TRAINING. LANGUAGE STUDY IS A SERIOUS AND LEGITIMATE NATIONAL DEFENSE ISSUE. ONLY LAST YEAR, THE DEPUTY DIRECTOR OF THE CIA, ADMIRAL BOBBY R. INMAN, TESTIFIED THAT THE DEFENSE COMMUNITY HAS BEEN "SEVERELY IMPACTED" BY THE DECLINE IN FOREIGN LANGUAGE STUDY. A NUMBER OF DEFENSE SPECIALISTS HAVE BEEN OUTSPOKEN IN NOTING THAT THE SHORTAGE OF QUALIFIED LINGUISTS COINCIDES WITH AN INCREASED DEMAND FOR THESE SKILLS AND THAT THE CONTRIBUTIONS OF FOREIGN LANGUAGE COMPETENCE TO OUR NATIONAL SECURITY IS VITAL TO COMMAND, INTELLIGENCE, OPERATIONS, LOGISTICS AND SURVIVAL SKILLS. FOR EXAMPLE, A 1980 GAO STUDY CONSERVATIVELY ESTIMATED THAT THE DEPARTMENT OF DEFENSE HAS ABOUT 13,600 AUTHORIZED LANGUAGE ESSENTIAL POSITIONS. OF THESE POSITIONS, GAO FOUND THAT ONLY ABOUT FIFTY PERCENT WERE FILLED AT THE REQUIRED PROFICIENCY LEVEL OR FILLED AT ALL.

LANGUAGE STUDY IS EQUALLY IMPORTANT TO OUR TRADE AND

INTERNATIONAL ECONOMIC POLICY. LESS THAN ONE PERCENT OF AMERICA'S COLLEGE STUDENTS NOW STUDY THE LANGUAGES OF THREE-FOURTHS OF THE WORLD'S POPULATION; ALTHOUGH ONE OUT OF EIGHT MANUFACTURING JOBS IN THIS COUNTRY ARE DEPENDENT UPON EXPORTS, ONE OF EVERY THREE AMERICAN ACRES IS PLANTED FOR EXPORT AND ONE-THIRD OF OUR PROFITS COME FROM TRADE. IN AN ERA OF ECONOMIC INTERDEPENDENCE, THE DATA ARE COMPELLING - 35,000 U.S. BUSINESSMEN LIVE ABROAD, 6,000 U.S. COMPANIES HAVE OVERSEAS OFFICES AND 20,000 FIRMS ARE ENGAGED IN EXPORTING.

WHILE A GREAT DEAL MORE STUDY NEEDS TO BE DONE ON BUSINESS LANGUAGE NEEDS, THE FEW STUDIES WE HAVE NOW INDICATE A SERIOUS SHORTAGE OF INDIVIDUALS WITH LANGUAGE SKILLS. IN A 1975 STUDY OF 6,000 FIRMS BY OLYMPUS RESEARCH CORPORATION, A TWENTY-THREE PERCENT RESPONSE IDENTIFIED OVER 60,000 JOBS REQUIRING A SECOND LANGUAGE. A SURVEY JUST COMPLETED BY THE OHIO MODERN LANGUAGE ASSOCIATION OF BUSINESSES IN CINCINNATI, COLUMBUS, AKRON AND TOLEDO HAD A MAJORITY OF THE FIRMS RESPONDING INDICATING THAT A LANGUAGE PROFICIENCY WAS VALUABLE FOR SOME OR ALL OF THEIR PERSONNEL. PERHAPS THE BEST STUDY TO DATE IS ACE'S BUSINESS AND INTERNATIONAL EDUCATION WHICH NOTES, AMONG OTHER THINGS, THAT ABOUT THE ONLY THING BUSINESSES SENDING INDIVIDUALS OVERSEAS AGREE UPON IS THE VALUE OF LANGUAGE TRAINING.

THE OTHER SIDE OF THIS COIN IS THAT DOMESTICALLY IMMIGRATION, REFUGEES, TOURISM AND IMPORTING HAVE ALL

PRODUCED JOBS IN INTERPRETATION AND TRANSLATION (THERE ARE 72 TRANSLATION BUSINESSES LISTED IN THE D.C. YELLOW PAGES), SOCIAL SERVICES, SALES, HOTEL MANAGEMENT AND SO FORTH. THIS IS NOT TO SAY, OF COURSE, THAT BUSINESSES ARE HIRING INDIVIDUALS SOLELY FOR THEIR LANGUAGE SKILLS. THEY ARE, HOWEVER, SERIOUSLY LOOKING FOR LANGUAGE SKILLS AS A SUPPLEMENT. THESE ARE SKILLS WHICH SHOULD BE, BUT ARE NOT, PROVIDED BY OUR EDUCATIONAL SYSTEM.

LEGISLATION SUCH AS S. 530 IS VITALLY IMPORTANT TO ADDRESSING OUR NATIONAL NEEDS IN FOREIGN LANGUAGES. PERHAPS EVEN MORE THAN IN OTHER EDUCATIONAL AREAS, THE FEDERAL GOVERNMENT MUST ASSUME A LEADERSHIP ROLE IN ADDRESSING THE NATIONAL DILEMMA IN FOREIGN LANGUAGES AND INTERNATIONAL STUDIES. SINCE THIS IS AN ISSUE OF IMPORTANCE TO NATIONAL SECURITY AND ECONOMIC GROWTH, STATE AND LOCAL LEADERS WILL CERTAINLY LOOK TO NATIONAL LEADERS FOR DIRECTION AND INCENTIVES. THERE HAS ALREADY BEEN SOME HEIGHTENING OF AWARENESS. THE LAST TWO SECRETARIES OF EDUCATION HAVE FORCEFULLY SPOKEN OF THE IMPORTANCE OF LANGUAGE STUDY. THE FINDINGS OF THE PERKINS COMMISSION CLEARLY DELINEATED THE EXTENT OF THE PROBLEM, AND WE ANTICIPATE THAT THE NATIONAL COMMISSION ON EXCELLENCE IN EDUCATION WILL ELABORATE IT. THIS WEEK IS NATIONAL FOREIGN LANGUAGE WEEK BY PRESIDENTIAL PROCLAMATION - A TRADITION BEGUN BY PRESIDENT CARTER. BUT AT THIS POINT, WE ARE STILL "JAWBONING" THE PROBLEM (TO BORROW FROM THE JARGON OF ANOTHER DISCIPLINE).

WHILE NATIONAL ATTENTION IS IMPORTANT, THIS APPROACH TAKES TIME, AND WITH A FEW EXCEPTIONS, IT IS UNLIKELY THAT LOCALITIES, WITH VERY LIMITED FINANCIAL RESOURCES, WILL MOVE TO ADDRESS WHAT THEY ACCURATELY PERCEIVE AS A NATIONAL AND INTERNATIONAL CONCERN WITHOUT SOME FEDERAL COMMITMENT. ONE ESTIMATE IN A RELEASE BY STANFORD UNIVERSITY ANNOUNCING THEIR RE-INSTITUTIONAL LANGUAGE REQUIREMENTS WAS THAT THE COST TO EXPAND LANGUAGE PROGRAMS TO IMPLEMENT LANGUAGE REQUIREMENTS IS $125 PER STUDENT. THE COST IS EVEN HIGHER FOR SMALL COLLEGES AND THE LESS COMMONLY TAUGHT LANGUAGES. CONSEQUENTLY, IT IS NECESSARY TO PROVIDE FUNDS TO ASSIST EDUCATIONAL AGENCIES AND INSTITUTIONS AT ALL LEVELS WITH THE COST OF INSTRUCTION, MATERIALS AND TRAINING. EQUALLY IMPORTANT, HOWEVER, IS THAT THESE FUNDS PROVIDE EVIDENCE OF A COMMITMENT TO OVERCOMING A NATIONAL EMBARRASSMENT WHICH THREATENS OUR SECURITY AND ECONOMIC COMPETITIVENESS.

THE URGENT NEED FOR INCENTIVES, AT ALL EDUCATIONAL LEVELS, CANNOT BE OVERSTATED. OF EQUAL IMPORTANCE, HOWEVER, IS THAT WE CANNOT AFFORD TO CUT BACK EXISTING PROGRAMS WHICH PROVIDE FUNDING FOR FOREIGN LANGUAGE EDUCATION.

THE ADMINISTRATION'S PROPOSED ELIMINATION OF TITLE VI FUNDING FOR FOREIGN LANGUAGES AND AREA STUDIES PRESENTS YET ANOTHER THREAT TO THE STATE OF FOREIGN LANGUAGE STUDY IN THIS COUNTRY. THE ZERO FUNDING LEVEL FOR FY 84, WHICH WOULD BE DECREASED FROM $26 MILLION IN FY 83, IS CLEARLY A MOTION WHICH OVERLOOKS THE POSITIVE ATTRIBUTES OF FOREIGN LANGUAGES IN THE LONG-TERM ECONOMIC AND STRATEGIC

INTERESTS OF OUR NATION.

TITLE VI CURRENTLY SUPPORTS NINETY NATIONAL RESOURCE CENTERS FOR FOREIGN LANGUAGE AND INTERNATIONAL STUDIES, WHERE NEARLY 80% OF THE NATION'S FOREIGN LANGUAGE TRAINING IN THE LESS COMMONLY TAUGHT LANGUAGES OF AFRICA, ASIA, LATIN AMERICA, THE SOVIET UNION, AND EASTERN EUROPE TAKE PLACE. ALTHOUGH FEDERAL FUNDS HAVE NEVER SURPASSED TEN TO FIFTEEN PERCENT OF THE OPERATING COSTS OF THE CENTERS, SUCH FUNDS HAVE BEEN VITAL IN ATTRACTING FURTHER FINANCIAL SUPPORT FROM INSTITUTIONAL, STATE, AND PRIVATE SOURCES. THE ABSENCE OF FEDERAL FUNDING COULD SEVERELY JEOPARDIZE SUPPORT FROM THE PRIVATE SECTOR.

THE PLANNED ELIMINATION WOULD TERMINATE FELLOWSHIP SUPPORT FOR SOME 700 GRADUATE STUDENTS ALREADY ENGAGED IN AFRICAN, ASIAN, LATIN AMERICAN, MIDDLE EASTERN, SOVIET AND EASTERN EUROPEAN LANGUAGE STUDIES. SUCH STUDIES ARE UNIQUELY COSTLY AND LONG-TERM DUE TO THE DESIRABILITY OF SPENDING A PORTION OF TIME CONDUCTING RESEARCH IN THE COUNTRY OF SPECIALIZATION.

THE BUDGET WOULD FURTHER END SUPPORT FOR A MINIMUM OF 35 GRADUATE AND UNDERGRADUATE INTERNATIONAL STUDIES PROGRAMS AS WELL AS HALT THE NEW MATCHING GRANTS PROGRAM IN BUSINESS AND INTERNATIONAL STUDIES, AN AREA WHERE INITIATIVES ARE VITAL.

AT A TIME WHEN LANGUAGE CONCERNS ARE BEING RECOGNIZED AS IMPORTANT AND WE HAVE SEEN A SLIGHT AND TENUOUS REVIVAL IN DEMAND FOR THEM, WE CAN ILL-AFFORD TO LOSE THE VERY

LIMITED FUNDING WHICH NOW SERVES AS THE ONLY POSITIVE ATTEMPT TO STRENGTHEN THE LINKAGE BETWEEN LANGUAGE AND INTERNATIONAL STUDIES AND THE NATION'S SECURITY AND ECONOMIC WELL-BEING.

IN CONCLUSION, THANK YOU FOR THIS OPPORTUNITY TO OFFER OUR COMMENTS. I HAVE TRIED TO BE AS COMPREHENSIVE AS POSSIBLE IN DISCUSSING THE DIMENSIONS OF OUR FOREIGN LANGUAGE SHORTAGES AND NATIONAL NEEDS. AS A CONSEQUENCE, I MAY HAVE SLIGHTED SOME AREAS OF IMPORTANCE AND RAISED AS MANY QUESTIONS AS I HAVE ANSWERED. I WOULD BE PLEASED TO ELABORATE OR TO ANSWER ANY QUESTIONS YOU MIGHT HAVE.

Senator **Stafford**. Thank you very much, sir. I overlooked the fact that you were supposed to have been next, Reverend Byron, so now I will correct that by coming back to you.

Father **Byron**. Thank you, Mr. Chairman. I know we are not here to talk about student aid, but I cannot resist the opportunity to thank you for the help you gave us during the last session, and we are very grateful for that, and also to Senator Pell.

The problem that we are dealing with today, of course, is wide and it is very deep. I think the deepdown problem is one of motivation. Why do we resist the acquisition of quantitative skills? Why do we resist the study of mathematics and science? Why do we resist foreign languages?

So I think research is needed to discover explanations for the absence of motivation and then even more research to find methods for filling that void. Federal funding of such research would be a very good investment.

It is also my view that the primary target for public policy responses to this problem before your committee—the primary target should be the teachers: the attraction, the retention of excellent science, mathematics, and language teachers in our elementary, high school, college, and university classrooms.

In this I mean to include more than the recruiting and training of new teachers. I have very much in mind the renewal and the reward of those relatively underappreciated and certainly undercompensated teachers already in the classroom.

All of us need better equipment, and Federal funds should help us acquire it. But the best equipment will not assist the motivated learner unless that equipment is passed to the student through the hands of a creative, dedicated, energetic, highly motivated, and adequately compensated teacher.

It can be argued that the most important work going on in America at this hour is in the Nation's classrooms. And as that work goes, so goes just about everything we value for our national life.

So, Mr. Chairman, target on the teachers. Foster the research that we need on new instructional technologies, and I am sure the research community will respond to requests for proposals. Perhaps funds would be well spent first on a few conferences designed to identify the central research questions that touch on this problem.

By all means, provide fellowship and scholarship support for students interested in teaching careers, and be generous in funding renewal workshops for teachers already in the field.

Let me conclude with a plea for the house in which this work of teaching mathematics, science, and foreign language will continue to take place; namely, the physical plant and the equipment necessary for this intellectual formation. In so many cases, the house is in a state of physical decay, and the equipment is obsolete. It comes down to a question of a balanced support of both plant and persons.

Replacement and renewal of plant should accompany strategies for the recruitment and renewal of persons in the teaching profession. Such renewal will produce an environment within which the cultivation of that motivation to learn is more likely to succeed.

At bottom the problem of motivation remains to be solved. In this regard, money is not the ultimate solution, but without more money—money for teaching salaries and for learning fellowships—without more money, no national solution is likely to emerge.

Perhaps Federal assistance to the learners should be enhanced by special merit scholarships directed toward national need, recognizing, however, that the Nation needs poets and philosophers, as well as mathematicians and microbiologists.

With respect to teachers' salaries, I recommend Federal support of sabbaticals, those summer study stipends that we have heard of earlier today, and, of course, generous research grants. I also suggest that tax credits for teachers be considered, as well as nontaxable Federal bonus awards to full-time teachers at stated intervals in their careers. I recognize we are not here to consider tax legislation, and I also recognize this is not a policy proposal for a deficit plagued Federal budget, but it does seem to me that if we are relating this to the productivity of the Nation and to the health of the economy where investment tax credits are very freely discussed, why not give teacher tax credits so that the compensation of teachers could thus be enhanced? I do think that what I am raising here is a policy question to be taken seriously by those searching for means of motivating those who have the talent needed to overcome the national problem being considered by this committee.

Thank you, Mr. Chairman.

Senator STAFFORD. Thank you very much, Reverend Byron. The Chair will just comment that in connection with your recommendations concerning plant, that another hat I wear is chairman of the Environment and Public Works Committee. And there we are looking under the new buzzword "infrastructure" at some jobs legislation which, as we now contemplate it, would include the refurbishing of the schools of America as a necessary job that needs to be done that could be expedited in order to put people back at work this year and next year and 1 or 2 years beyond that. So we recognize it, but we are trying to reach that part of it through a different committee and a somewhat different tack.

Father BYRON. I applaud that. I had an essay on the op-ed page of the Washington Post a month ago about the renewal of research libraries. Perhaps I could submit that for the record or to you directly.

Senator **Stafford**. You certainly may; it will be made part of the record.

Father **Byron**. Thank you.

[The prepared statement of Reverend Byron and the essay referred to follow:]

TESTIMONY OF
REVEREND WILLIAM J. BYRON, S.J.
PRESIDENT
THE CATHOLIC UNIVERSITY OF AMERICA

BEFORE THE

COMMITTEE ON LABOR AND HUMAN RESOURCES
SUBCOMMITTEE ON EDUCATION, ARTS AND HUMANITIES

MARCH 9, 1983

Mr. Chairman and Members of the Subcommittee:

My name is William Byron; I serve as President of The Catholic University of America. I am here today to offer my personal views; I am not representing any of the educational associations.

Mr. Chairman, discussion in the 98th Congress on the question of mathematics and science education began, I believe, with HR 30, a bill designed to meet the "crisis" facing our nation in this area. I testified on behalf of the higher education community in support of HR 30, a bill which included elementary, secondary and higher education. Discussion and eventual passage of that bill enlarged the issue, as you know, to include the need of our nation to improve its mastery of foreign languages as well.

The point I would make today is this. Meeting a crisis is necessary but insufficient if we want to get at the deeper problem, a problem that is nationwide and culturally very deep. As a nation, we resist both the study of foreign language and the development of scientific and mathematical skills.

We must cultivate in our young a love, not a fear of science and mathematics. We must encourage families to reinforce scientific curiosity. Similarly, we must motivate our young to study foreign languages. Parental reinforcement is needed for languages too. The deep-down problem is one of motivation.

I think research is needed to discover explanations for the absence of motivation and then more research to find methods for filling that void. Federal funding of such research would be an excellent investment.

It is also my view that the primary target area for public policy responses to our problem should be on teachers--the attraction and retention of excellent science, mathematics and language teachers in our elementary, high school, college and university classrooms. In this I mean to include more than the recruiting and training of new teachers. I have very much in mind the renewal and reward of those relatively under-appreciated and certainly under-compensated teachers already in the classrooms.

All of us need better equipment and federal funds should help us acquire it. But the best equipment will not assist the motivated learner unless that equipment is passed to the student through the hands of a creative, dedicated, energetic, highly motivated and adequately compensated teacher.

It can be argued that the most important work going on in America at this hour is in the nation's classrooms. As that work goes, so goes just about everything we value for our national life.

So, Mr. Chairman, target on the teachers. Foster the research we need on new instructional technologies. I'm sure the research community will respond to requests for proposals. Perhaps funds would be well spent first on a few conferences designed to identify the central research questions.

By all means provide fellowship and scholarship support for students interested in teaching careers. And be generous in funding renewal workshops for teachers already in the field.

Let me conclude with a plea for the house in which this work of teaching mathematics, science and foreign language will continue to take place, namely, the physical plant and equipment necessary for this intellectual formation. In so many cases, the house is in a state of physical decay. The equipment is obsolete.

It comes down to a question of balanced support of plant and persons. Replacement and renewal of plant should accompany strategies for the recruitment and renewal of persons in the teaching profession. Such renewal will produce an environment within which the cultivation of the motivation to learn is more likely to succeed.

At bottom, the problem of motivation remains to be solved. In this regard, money is not the ultimate solution but without more money--for teaching salaries and learning fellowships--no national solution is likely to emerge. Federal assistance to the learners should be enhanced by special merit scholarships directed toward national need (recognizing, however, that the nation needs poets and philosophers as well as mathematicians and microbiologists).

With respect to teachers' salaries, I recommend federal support of sabbaticals, summer study stipends, and generous research grants. I also suggest that tax credits for teachers be considered as well as non-taxable federal bonus awards to full-time teachers at stated intervals in their careers. This is not a policy proposal for a deficit-plagued federal budget. It is, however, a policy question to be taken seriously by those searching for means of motivating those who have the talent needed to overcome the national problem being considered by this Committee.

The Washington Post

AN INDEPENDENT NEWSPAPER

THURSDAY, FEBRUARY 3, 1983

William J. Byron

A Nickel-a-Book Tax?

A nickel a gallon for roads, bridges and mass transit. Why not a nickel a book for research libraries?

By imposing a five-cent tax on every gallon of gasoline sold, the federal government expects to generate $5.5 billion annually for road repairs. The motorists will pay for better highways. Predictably, the trucking industry is unhappy, but all users, heavy and light, will benefit, and hundreds of thousands of repair-related jobs will be filled. Relaxed size and weight restrictions on trucks eased passage of the bill. Nickel-a-gallon is now the law of the land.

Why muse over the possibility of a nickel a book for research libraries? There is no federal library system to speak of. Such a tax would, some will certainly argue, pose a threat to freedom of the press (although the telephone excise tax seems not to impair freedom of speech). Others will ask: What is a book? Are pamphlets exempt? Will magazines be next? Isn't the tax regressive? Why raise the issue at all?

Our research libraries are in need of repair. Retrofitting for the new library technology is an even greater need. New equipment is necessary for the new information systems. Roofs, pipes, wiring, shelving, walls and climate control require attention in most old libraries, of course. Construction and reconstruction jobs are waiting to be done: jobs would be generated.

But even if all our libraries were in perfect repair, a major unmet—and often unnoticed—capital need would remain. Scholarly periodicals will soon be published electronically. Scholarly output will be stored in computer banks, not printed journals. People will use the journal and the article by going to a terminal, not a shelf. Front-end capital costs of electronic journal depositories for scholarly output will be great. So will costs of placing terminals and display screens within reach of readers and researchers across the nation.

Publishers, already uneasy at the prospect of electronic journals, cannot be expected to hail the possibility of a nickel-a-book excise tax any more than the truckers welcomed the nickel-a-gallon on gasoline. The vast majority of book buyers, however, would follow the drivers in accepting the levy without protest. Revenues produced by this tax, if spent wisely on the improvement of research libraries, would guarantee that readers will have better books to buy in the decades ahead.

A federal initiative toward the improvement of research libraries would be a welcome signal that Uncle Sam expects the nation to tip its hat, instead of tapping its head, in the direction of those who dedicate themselves to scholarly research.

The writer is president of Catholic University.

Senator STAFFORD. Now, Dr. Smith, we would be very happy to hear from you.

Mr. SMITH. Thank you very much, Mr. Chairman. I am Joshua Smith, and I am the president of the Borough of Manhattan Community College of the City University of New York. And today I am wearing more than one hat because I am representing the American Association of Community and Junior Colleges and the Association of Community College Trustees by being the vice chair of the Joint Commission on Federal Relations.

This joint commission believes that our country should make at least as much of an investment in new skills development and human infrastructure improvement as the Congress seems inclined to make in public works infrastructure repair.

The aim of our joint commission is to encourage a broad national strategy that would harness the now fragmented Federal programs on job training and employment in the comprehensive development and full use of the Nation's human resources.

We believe that the House has made a good beginning in H.R. 1310, and wisely it is bringing the resources and leadership of the community colleges and of the National Science Foundation together to attack the private sector's pressing need for special skills in targeting 20 percent of the $100 million that title II provides for the National Science Foundation on strengthening the instructional models and faculty in high technology in the community and technical colleges.

The committee report from the Science and Technology Committee on H.R. 1310 observed, and I quote:

> The committee realizes that NSF has traditionally not been involved in community college programs. However, in view of the critical importance of technician training to the future of high technology industries, the committee believes strongly that the NSF must take responsibility for developing and demonstrating the most effective programs for technician training.
>
> The committee intends that funds under this section be used to develop and conduct model instructional programs, to purchase and lease appropriate instructional equipment, and to provide the opportunities for professional faculty development.

Unless we succeed in eliminating the technician gap, the leadership that the United States still maintains in technological and scientific discovery inevitably will decline. Repeatedly our scientific community turns out new technology only to have the Japanese steal the markets growing out of that technology because they have the technicians to move into production faster than we do, as Representative Gillis Long observed in the House Rules Committee deliberations on H.R. 1310.

Mr. Chairman, the bill that you and Senators Pell and Cranston developed last December and that Senator Pell reintroduced 2 weeks ago, the Education for Economic Security Act, you have recognized that the critical teacher shortages in math and science are not confined to the elementary and secondary schools, and you have earmarked nearly as much support for postsecondary teacher development as you have for teacher training in the lower school systems.

Partly because of our steady growth in enrollments—and I will parenthetically say the growth in my own college is so spectacular between semesters this year we increased by almost 30 percent—

and then partly because our technician programs are very popular and because our teaching salaries cannot meet industrial competition. The community colleges are grappling with grave shortages of faculty in the computer and electronics sciences and math and physics as well, and in my printed testimony I have included some tables that will give you some idea of the results of a national survey which the association recently took.

But as you go about blending H.R. 1310 with the Senate legislation, Mr. Chairman, we have two specific recommendations. If you maintain the set-asides which S. 530 proposes for vocational programs, then the postsecondary set-asides should equal the elementary, secondary set-aside.

As Dr. David Pierce, executive director of the Illinois State Community College Board noted in testimony before this committee last week, the data collected on vocational enrollments for the 1979–80 academic year by the National Center for Educational Statistics shows that 39 percent of all students in vocational programs were in postsecondary courses. And if only occupational specific programs were counted, the postsecondary share was 51 percent.

Community college growth would make that percentage even higher now, yet the set-aside prescribed by S. 530 for secondary programs in the emerging technologies would be 22.75 percent of the total funding for the bill, while the set-aside for postsecondary programs within the same area would just be 12.25 percent.

And that imbalance, we believe, tends to run counter to today's trends and to the reality which point us toward yet more advanced technician training beyond high school to serve the needs of industry for tomorrow.

Our second proposal goes to the other part of H.R. 1310, and that concerns the congressional scholarships to aid students who want to seek careers in teaching mathematics and science.

We endorse the concept, but we strongly recommend that students become eligible for the scholarships in their sophomore year of college rather than in the junior year. We believe that it is altogether too late to wait until the junior year to determine that a student is going to make the decision to go on into a career in education. We also believe that the student will not have the proper foundation in science and mathematics that would be required to make that person a good teacher.

In closing, Mr. Chairman, we would like to add to the hearing record the general statement of legislative priorities from the Joint Commission of ICCT and AACJC, entitled "Paramount Priority, Human Infrastructure." And that will accompany my prepared testimony, and we thank you again for the opportunity to appear.

[The prepared statement of Mr. Smith and the general statement referred to follow:]

TESTIMONY
on
MATHEMATICS, SCIENCE AND FOREIGN LANGUAGE EDUCATION

by

Joshua Smith
President
Borough of Manhattan Community College
New York, New York

on behalf
of the
American Association of Community and Junior Colleges
and the
Association of Community College Trustees

Mr. Chairman, the community colleges are very pleased to be invited to testify on legislation that may well prove to be the most important public policy that Congress addresses in this session. The task facing our country, of rejuvenating the national skills base, of rebuilding, if you will, the economy's human infrastructure, is one that requires the working together, the pulling together of all of us -- the Congress, the community colleges and the entire educational system, the governors, the private sector. We recognize that it is not a challenge that Congress alone can solve. Yet we look to you, Mr. Chairman, to chart the national strategy to meet it.

We have started off emphasizing the need to expand the general skills base, Mr. Chairman, because in our judgment, a depleted skills base has a lot to do with the problem which is the primary focus of your hearing, which is the insufficent supply and quality of math and science teachers at every level of education. If our skills base were keeping up with the needs of the emerging technology, if we were turning out technicians, engineers, scientists and mathematicians on the same relative scale that Japan, the Soviet Union and several other industrial rivals are, the Nation would have an easier time staffing the science, math and technology programs of its schools and colleges with qualified personnel. Industrial competition would less constantly bleed our faculties, and we would cease to devour the "seed corn" of our own national productivity.

Even though the push we made in the sciences a generation ago in the wake of Sputnik culminated in the United States capturing the space lead and putting the first man on the moon, hindsight shows us that it was not a commitment and success in which the whole learning and training establishment shared, as it ought to have been. It was a push concentrated in a smaller scientific community -- in somewhat the fashion of the Manhattan Project of an earlier generation.

Let's not make the same mistake in tackling the present crisis. And let's not make the mistake of thinking we can turn it around overnight. The fact that Japan, with half our population, is turning out twice as many engineers as we are speaks to a momentum that we cannot match with simple jobs programs. What our Nation must have, in our judgment, is a "moon shot" commitment to the development of its human capital, a commitment reaching every corner of the economy, every level of the workforce.

In fact, Mr. Chairman, it is the concensus of the American Association of Community and Junior Colleges and the Association of Community College Trustees, both of which I represent here today as Vice Chairman of their Joint Commission on Federal Relations, that our country should make at least as much of an investment in new skills development and human infrastructure improvement as the Congress seems inclined to make in public works infrastructure repair. The aim of our Joint Commission is to encourage a broad national strategy that would harness the now fragmented federal programs on job training and employment in the comprehensive development and full use of the Nation's human resources.

The House has made a good beginning in H.R. 1310. Wisely, it is bringing the resources and leadership of the community colleges and of the National Science Foundation together to attack the private sector's pressing need for special skills. In targeting 20 percent of the $100 million that Title II provides for the National Science Foundation on strengthening the instructional models and faculty in high technology in the community and technical colleges, the Committee Report from the Science and Technology Committee on H.R. 1310 observes,

> "The Committee realizes that NSF has traditionally not been involved in community college programs. However, in view of the critical importance of technician training to the future of high technology industries, the committee believes strongly that the

> NSF must take responsibility for developing and demonstrating the most effective programs for technician training. The Committee intends that funds under this section be used to develop and conduct model instructional programs, to purchase and lease appropriate instructional equipment, and to provide opportunities for professional faculty development."

Unless we succeed in eliminating the technician gap, the leadership that the United States still maintains in technological and scientific discovery inevitably will decline. Repeatedly, our scientific community turns out new technology only to have the Japanese steal the march in markets growing out of that technology, because they have the technicians to move into production faster than we do, as Representative Gillis Long observed in the House Rules Committee deliberations on H.R. 1310.

Mr. Chairman, in the bill that you and Senators Pell and Cranston developed last December and that Senator Pell reintroduced two weeks ago, the Education for Economic Security Act, you have recognized that the critical teacher shortages in math and science are not confined to the elementary and secondary schools, and you have earmarked nearly as much support for postsecondary teacher development as you have for teacher training in the lower school systems. Partly because of our steady growth in enrollments, partly because of the high popularity of our technician courses, and partly because teaching salaries can't meet the industrial competition, the community colleges are grappling with grave shortages of faculty in the computer and electronics sciences, and math and physics as well.

If you examine the accompanying tables, you will see that the "critical shortages" and "shortages" of electronics and computer science instructors in community and technical colleges run almost 90 percent for the country as a whole. In math and physics, the shortages run 40 percent or higher. Again we stress that a large

Instructor Shortages in Community Colleges

Table #1

Total Response by Subject

	Critical Shortage	Shortage	Adequate	Surplus	Other
omputer Sciences	52%	37%	8%	0%	No Response 3%
lectronic Technology	31%	36%	15%	1%	No Response 13% Not Applicable 4%
athematics	7%	35%	47%	3%	No Response 8%
arth Sciences	1%	9%	63%	6%	No Response 18% Not Applicable 3%
hysics	6%	34%	44%	2%	No Response 14% Not Applicable 1%
hemistry	3%	24%	60%	3%	No Response 10%
usiness	3%	27%	55%	6%	No Response 9%

ther -- 34% of the respondents indicated shortages in "other" subjects.

ursing	28%
ther Allied Health Fields	20%
igh-Tech Fields	38%
ther	14%

Source: AACJC

Response by Region

Table #2

COMPUTER SCIENCE	Critical Shortage	Shortage	Adequate	Surplus	Other
Region I (CT, MA, ME, NH, RI, VT/5%)*	45%	45%	9%	0%	
Region II (NJ, NY/7%)*	70%	30%	9%	0%	
Region III (DC, DE, MD, PA, VA, WV/9%)*	54%	41%	5%	0%	
Region IV (AL, FL, GA, KY, MS, NC, SC, TN/20%)*	63%	29%	7%	0%	No Response 1%
Region V (IL, IN, MI, MN, OH, WI/19%)*	51%	37%	9%	0%	No Response 4%
Region VI (AR, LA, NM, OK, TX/9%)*	40%	48%	10%	0%	No Response 2%
Region VII (IA, KS, MO, NE/7%)*	38%	47%	12%	0%	No Response 3%
Region VIII (CO, MT, ND, SD, UT, WY/4%)*	44%	44%	6%	0%	No Response 6%
Region IX (AZ, CA, HI, NV/11%)*	54%	33%	11%	0%	No Response 2%
Region X (AK, ID, OR, WA/6%)*	33%	48%	11%	0%	No Response 7%

* -- /% = Number of Region Responses/Total Responses

Source: AACJC

part of the solution to these shortages will lie in replenishment of the general technical skills base, because a larger pool, among other benefits, will mean that more professionals will be available as adjunct faculty to bolster science, math, and technology instruction at every level of the educational system.

Apart for the community colleges' importance as an immediate source of skilled technicians — they are easily the largest source outside industry itself, with their total enrollment in occupational programs running about twice that of the proprietary trainers — they also perform a growing linkage function in the overall educational system which serves skills needs and national productivity more broadly. On the one hand, by their general growth and by their specific growth in applied science and applied technology, they supply more and more of the students who eventually will earn higher degrees in science, engineering and math. At the same time, as a matter of both self interest and community need, many are expanding their outreach to secondary schools, to help enrich instruction in the basics.

I might illustrate this linkage function with programs at my own college. The Borough of Manhattan Community College is one of the few community colleges that has received a Minority Institutions Science Improvement Program grant, which has enabled us to acquire hardware and develop software for computer-assisted individualized remedial instruction helping students in biology, chemistry and physics. Our math department provides by computer remedial instruction in basic arithmetic, algebra, statistics, logic, and pre-calculus. Our accounting and business departments are aggressively seeking funds to acquire microcomputers for individualized and remedial instructional support for all business and accounting students. Finally, we offer computer methods in science courses for all science majors enrolled in the college.

To prepare students to meet technical industry needs, we offer a full-range data processing programs with options for concentration in either computer programming or operations. In response to the rapid emergence of the electronic office in the work place, we have revised our initial secretarial science curriculum to incorporate high-level skill training in all phases of word processing and modern office technology. To meet the high demand for well-trained and skilled technicians in television, cable and other media industries, we have this year launched a corporate and cable communication degree program which is heavily subscribed among students and welcomed with support by the industry.

Our Cooperative Education program is one of our major vehicles of outreach to the world of work. Students are out-placed in real-work situations, under supervision, in many of the industries in greater New York's industrial, office and managerial communities.

As you go about blending H.R. 1310 with the Senate legislation, Mr. Chairman, we have two specific recommendations. If you maintain the setasides which S. 530 proposes for vocational programs, then the postsecondary setaside should equal the elementary-secondary setaside.

As Dr. David Pierce, Executive Director of the Illinois State Community College Board, noted in testimony before this Committee last week,the data collected on vocational enrollments for the 1979-80 academic year by the National Center for Educational Statistics shows that 39 percent of all students in vocational programs were in postsecondary courses; and if only occupational-specific programs were counted, the postsecondary share was 51 percent. Community college growth would make that percentage even higher now. Yet the setaside prescribed by S. 530 for secondary programs in the emerging technologies would be 22.75 percent of the total funding for the bill, while the setaside for postsecondary programs with the same aim would be just 12.25 percent. That imbalance runs counter to both today's reality and the trend toward yet more advanced technician training beyond high school for industry's needs of tomorrow.

Our second proposal goes to the other part of H.R. 1310, the provision of Title I establishing Congressional Scholarships to aid students seeking teaching careers in math and science. We strongly recommend that students become eligible for the scholarships in their sophomore year of college. The program as written by the House, taking candidates no earlier than their junior year, risks forsaking the largest single source of potential teachers, since the community colleges have more lower-division students than the rest of higher education. Our freshman and sophomores also provide the largest numbers of minority candidates in any segment of American higher education. The notion held by some minority members of the House Committee on Education and Labor that students don't make a serious choice of a teaching career until they are juniors or seniors is unsubstantiated. Quite the contrary, a strong foundation in math and science requires solid interest and solid courses in these fields long before the student reaches college; and the full preparation of a qualified teacher, certification standards being what they are, requires a commitment and planning in that direction long before the last two years of college.

In closing, Mr. Chairman, we would like to add to the hearing record the general statement of legislative priorities from the Joint Commission of ACCT and AACJC, entitled "Human Infrastructure: Paramount Priority," which accompanies my prepared testimony. We thank you again for this opportunity and we will gladly answer any questions you may have.

Reprinted from the April 1983 issue of
The Community and Junior College Journal

U.S. Congress:
AACJC/ACCT
AGENDA

The statement that follows represents the comprehensive view of the legislative principles and aims that the Joint Commission on Federal Relations has developed for the American Association of Community and Junior Colleges and the Association of Community College Trustees. The Commission's Task Force that authored this statement was headed by Joshua L. Smith, vice chairman of the Joint Commission and president of the Borough of Manhattan Community College, New York.

JOINT COMMISSION ON FEDERAL RELATIONS

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Human Infrastructure: Paramount Priority

Without question, the final years of this decade and this century will be dedicated to the work of economic recovery. And central to any policy designed to boost the economy—be it at the local, state, or national level—must be education... the training and retraining of our work force. Community colleges have emerged as a pivotal, critical, flexible, leading partner in this national economic development effort. They offer a major community resource of learning that is accessible, easily integrated with the community and business organizations, prime resources for training new job skills—all at a lower cost.—Governor James R. Thompson of Illinois, March 1983.

In the crises of the past, the American people have consistently found the strengths to turn adversity into growth and opportunity. Today, however, emerging technology, sagging productivity, and heightened international competition pose for the American economy a crisis quite different in substance from any the nation has faced before.

Chronic unemployment, plant closings, waves of small business failures and home foreclosures, and mounting public and private debt have become stark reminders that Americans no longer can take their competitive edge for granted. The industrial, financial, educational, and natural resources that provided such an edge in the past century no longer will be sufficient alone to ensure prosperity.

Though the United States continues to lead the world in scientific and technological discovery, American industry finds itself without the skilled work force in many areas to match rival countries in turning new technology into increased production. Deficiencies in the work force, unless corrected soon, will have profound permanent effects on the structure of the economy and on the nation's ability to remain self-sufficient in fields vital to both national security and domestic well-being. "The path to economic recovery is," in the words of the chairman of the U.S. Senate's Subcommittee on Employment and Productivity, Senator Dan Quayle, "a long one... at the end of it is a labor market whose opportunities will be different from those of today." It is a path with which the community colleges are already familiar.

In hundreds of population centers across the nation, the community colleges are in the front lines of the nation's economic struggle. The five million learners now taking credits and degrees in these colleges mirror many of the personal hardships, sacrifices, and career aspirations that are shaping the American work force of today and tomorrow.

More than three million of these students are in occupational courses—programs increasingly attuned to both emerging technology and employer-specific training. There is growing recognition, from local industry to Capitol Hill, that community colleges are increasingly vital to the replenishment of the national skills base. That recognition has been underscored by this Congress in H.R. 1310, the Emergency Science and Mathematics Act, which directs the National Science Foundation to work with the community colleges to strengthen faculty in high technology and develop model instructional programs that will help industry and science overcome their technician shortages.

It has become the consensus of the community colleges, represented by the American Association of Community and Junior Colleges, the Association of Community College Trustees, and their Joint Commission on Federal Relations, that a wise nation should spend as much on skills repair as it may spend on infrastructure repair. The broad aim of the Joint Commission is to encourage legislation that would unify the now fragmented federal programs on job training and employment into a national strategy aimed at the full use of the nation's human capital. As a matter of principle, the community colleges believe that democratic government has no higher duty than to ensure that those who want to work will have jobs—an aim that should stand at least as high in national priority as national defense.

AACJC/ACCT AGENDA

The same aim is woven into each of the Joint Commission's more specific legislative objectives, which propose that Congress:

I. Expedite the passage of H.R. 1310, ensuring that it will be funded for FY 83.

II. Reconstruct the Vocational Education Act with a new section for employment development, training, and retraining to serve out-of-school youth and adults—aimed at total VEA funding of $1 billion.

III. Support the current student financial aid base, making the substantial increases in Pell Grants, College Work-Study, and the cost-of-attendance formula that President Reagan has requested. The State Student Incentive Grant program (SSIG), which has encouraged states to put nearly one billion additional dollars into their own student financial aid programs, should be maintained.

IV. Enact the military technician training bills, H.R. 1937 and S. 801, enabling the military services to use high-tech programs in community colleges.

V. Support legislation, such as the Grassley bill, S. 106, that allows tax benefits to businesses and industries that provide state-of-the-art equipment and faculty assistance to postsecondary occupational programs.

VI. Direct the states to allow citizens who are drawing unemployment compensation benefits to pursue full-time training, and to make referrals to training the automatic alternative when job referrals fail to provide reemployment.

VII. Ensure that reauthorization of the Higher Education Act is responsive to the growing role of community colleges in postsecondary education, also that Title III is renewed.

The Commission has based its recommendations on the following considerations:

I.
POSTSECONDARY TRAINING IN HIGH TECHNOLOGY

The Emergency Mathematics and Science Education bills, which have taken early priority in the 98th Congress, are a pivotal step toward the revitalization of the nation's skills base, and should become law in time to allow FY 84 funding. H.R. 1310 recognizes that the skills gap that is undermining American productivity cannot be closed by a more adequate teacher supply alone. In the Committee Report accompanying H.R. 1310, the Committee on Science and Technology has emphasized:

> 4. *Priorities for use of funds...*
>
> *(2) Two-year and community college instruction and faculty development*
>
> Section 205(a)(2) and 205(b)(1) earmark 20 percent of the Engineering and Science Personnel Fund for two-year and community colleges to provide high competence technician training in high technology fields. The Committee realizes that NSF has traditionally not been involved in community college programs. However, in view of the critical importance of technician training to the future of high technology industries, the committee believes strongly that the NSF must take responsibility for developing and demonstrating the most effective programs for technician training. The Committee intends that funds under this section be used to develop and conduct model instructional programs, to purchase and lease appropriate instructional equipment, and to provide opportunities for professional faculty development. The Committee specifically intends to require that funds be distributed with balance among these purposes with not more than 50 percent of such funds being used for any one purpose.
>
> It is the Committee's view that a major emphasis in funding be on model instructional programs to provide technician training in view of the central role technicians must play in our future economy. NSF is encouraged to direct its efforts to establish and improve instructional programs which are especially designed to serve displaced and long-term unemployed workers. The Committee intends that the NSF shall support commu-

nity college instructional programs that include partnerships with private employers and, in awarding grants, assure a wide geographic distribution of funds so that developments in this area will provide a nationwide base for future progress.

To ensure the success of the matching grants on which the postsecondary title of this legislation is based, Congress should provide tax incentives to industry that will stimulate state-of-the-art equipment gifts as a frequent source of such matches. Congress should also make college sophomores eligible for the Congressional scholarships proposed for prospective math and science teachers, since two-year colleges have the largest concentrations of students starting college.

II.
VOCATIONAL EDUCATION

The rush of new technology, and the global economic competition that feeds on it, is revolutionizing the skill demands of both office and factory, and changing dramatically the focus of vocational education. This is abundantly evident in the dramatic growth of occupational programs in the nation's community and technical colleges in the past decade, and in the soaring numbers of employer-specific courses they give for the private sector. Now the largest sector of American higher education in the learner populations they serve, the community colleges currently serve more than five million adults in their credit and degree programs, with nearly 65 percent of that number in technician and occupational courses. At least another million learners are using community colleges to learn or upgrade job skills and are ignoring the credits simply because they have higher degrees.

The reauthorization of the Vocational Education Act should be attuned to these developments. The Act's present setaside for postsecondary programs, now at 15 percent, should be at least doubled, allowing states whatever flexibility they may need to fill advanced job training needs through community colleges and other postsecondary vocational programs. Further, the new Act should provide an independent postsecondary title that expands career training opportunities for adults and out-of-school youth, giving priority to unmet skill needs in the emerging technologies. Like the Job Training Partnership Act, the new VEA should target the larger share of the funding on instructional services. These funds should be distributed as institutional grants that "follow the learner" on a state-determined full-time equivalency (FTE) formula.

III.
FEDERAL STUDENT FINANCIAL AID PROGRAMS

Education is the lifeblood of a free society. To the United States, it is no less important to the quality of the work force and to the health of the economy, than it is to the maintenance of an enlightened citizenry. Only through the full use of its human capital and the expansion of its skills base can the American economy maintain its leadership in scientific and technological discovery and in global commerce.

Since their inception a decade ago, Pell Grants have become the foundation of postsecondary educational access for lower-income and middle-income families. As the *Journal* of the American Association of Community and Junior Colleges has observed:

> *The yardstick that perhaps best indicates the impact of the Pell Grants on the nation, the economy, and the individual aspirations of learners, is a comparison with the GI Bill. In just one decade more than 18 million students have been helped to test their talent and ambition by the Pell Grants. In the 38 years since the GI Bill began, some 18.1 million veterans have used the educational benefits.*

The 98th Congress should continue to increase the funding for this program, lifting its FY 84 support to the $3 billion ceiling set by the Budget Reconciliation Act of 1981. The President's budget proposals to fund College Work-Study, again a program that has contributed heavily to the ability of less affluent students to gain career training, at $850 million, and to raise the cost-of-attendance allowance on grant awards to commuter students to $3,000, should also be adopted by the Congress.

AACJC/ACCT AGENDA

Congress should also continue to fund the other campus-based student aid programs. Eliminating the State Student Incentive Grant program, as the budget proposes, would be inconsistent with the President's initiative on "federalism," since SSIG is a notable example of growing state support triggered by a modest federal incentive. States are now allocating more than $1 billion annually to their own scholarship funds, primed by the modest federal SSIG incentive.

IV.
MILITARY TECHNICIAN TRAINING

In the monograph *Toward a Consensus on Military Service* (June 1982), the Atlantic Council of the United States and its influential Working Group on Military Service asserted in the summer of 1982:

> *The quality of Army recruits in recent years, as measured by test scores and the possession of high school diploma... has often fallen below that of the draft years, and even the early years of the volunteer force.... Higher quality becomes ever more essential with the growing sophistication of weaponry....*
>
> *It is clear that the Army's reinforcement capability is much less than that needed to provide confidence in a successful conventional defense.*

Bills directly responsive to the skills issues raised by the Atlantic Council have been introduced in the 98th Congress by senior members of the House and Senate Committees on Armed Services—H.R. 1937 by Representative Charles E. Bennett, D-FL, and S. 801 by Senator Strom Thurmond, R-SC. This legislation—which would make technician training adapted to the advanced weapons systems more readily, and less expensively, available to enlistees in both the regular services and their reserve units through associate degree courses—has attracted the endorsements of the boards of directors of the Aerospace Educational Foundation and the Air Force Association, and the commander-in-chief of the Veterans of Foreign Wars, among others. Confronted by spiraling defense costs, members of Congress should insist upon early hearings on SERTA. A leading scholar and consultant to both the Army and the Navy on their training programs, Walter E. Muller, senior staff scientist at George Washington University's Institute of Management, Science and Engineering, calculates that SERTA, if fully implemented, could bring cost savings of as much as $10 billion by 1987.

V.
TAX INCENTIVES ON HELPING COLLEGES

On almost every community college campus, one or more occupational courses is hampered by outdated equipment and insufficient faculty to instruct technician courses, particularly in electronic and computer sciences. This need is addressed in S. 108, in which Senator Charles E. Grassley proposes tax benefits to industries that help fill both needs.

Because state-of-the-art equipment is no less important to advanced technician training than it is to university research, the Grassley legislation extends to postsecondary occupational programs the same eligibility for equipment gifts from industry that the 1981 tax reforms provide for university research. Equally important to the mastery of state-of-the-art in occupational programs are the tax credits S. 108 would provide to companies on the personnel they permit to instruct postsecondary occupational programs and on part-time jobs given regular faculty from these programs. The latter is indispensable in giving faculty hands-on experience in the fields they teach.

The House of Representatives should provide leadership in initiating similar legislation.

VI.
UNEMPLOYMENT COMPENSATION

Congress should rewrite the law on unemployment compensation so that the benefits serve as an incentive rather than an impediment to the pursuit of new job skills. Various states persist in the policy of disallowing unemployment compensation to workers who enter full-time training when they have lost their jobs. While removing this authority from the states, the Congress

AACJC/ACCT AGENDA

also should specify that referral to training becomes the automatic alternative to job referrals when the latter fail to produce reemployment.

VII.
HIGHER EDUCATION ACT

The Joint Commission's immediate concern in HEA centers on realistic funding for existing programs, particularly the student financial aid programs and Title III assistance to developing colleges. The community colleges commend President Reagan on his budget increases for Title III. Title III continues to be an important source of assistance to community colleges as they strive for excellence in their areas of growth.

However, the President's proposal to restructure Pell Grants as "self-help" grants should be weighed carefully. Not only is the existing program profoundly successful, but the "self-help" concept could, by requiring every aid applicant to cover 40 percent of the costs of starting college, deny access to great numbers of economically disadvantaged learners. With unemployment among black youth touching 50 percent, the earnings necessary to meet the "self-help" test could prove unachievable for many such youth.

Modifications to the Higher Education Act should be handled in the general reauthorizaton process.

Further, the Joint Commission supports the renewal, through S. 249, of the tax-code provisions that exclude any tuition that an employer pays for an employee's training from the latter's taxable income.

The commission *opposes tuition tax credits.*

In 1947, the Truman Commission on Higher Education produced a penetrating look at the responsibilities that education would bear for the social and economic development of the nation. In the eyes of the AACJC/ACCT Joint Commission, the Truman Commission's judgment has been affirmed, and the responsibilities of education magnified by the present skills crisis. Among other findings, the Truman Commission concluded:

"The importance of economic barriers to post-high-school education lies in the fact that there is little if any relationship between the ability to benefit from a college education and the ability to pay for it....

"The American people should set as their ultimate goal an educational system in which at no level—high school, college, graduate school, or professional school—will a qualified individual in any part of the country encounter an insuperable economic barrier to the attainment of the kind of education suited to his appetites and interests....

"To achieve this, it will be necessary to develop much more extensively than at present such opportunities as are now provided by the...community college....

"...such community colleges will have to carry a large part of the responsibility for expanding opportunities in higher education."

The goals of the Truman Commission have been only partially realized. In their larger fulfillment lies the fuller utilization of the nation's human capital and a higher level of national productivity.

AACJC/ACCT Joint Commission on Federal Relations

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Senator STAFFORD. Thank you, Dr. Smith. That will be made a part of the hearing record.

The Chair wants to express its appreciation to all of you for closely observing our 5-minute timespan in this crowded morning. I have one question that I would like to ask the panel generally and others that I will submit in writing, if that is agreeable.

This question I would ask the panel's advice on is as follows: as you know, the National Defense Education Act contains provisions for student loan forgiveness for teaching service in specific poverty areas or in other areas of teaching shortage. Some of the proposed legislation the committee will consider for increasing the number of math and science teachers also includes loan forgiveness provisions.

So, my question is: Is loan forgiveness sufficient incentive for students to choose teaching careers or to change to science or math from another field of study?

We might start from the left and move to the right. Dr. Smith, do you have a comment?

Mr. SMITH. If you will allow me to be personal, Mr. Chairman, I was a recipient of an NDEA loan, and a good portion of that was forgiven, and I became a secondary schoolteacher. And then later I moved into the university and became a dean of education before this present position. I paid back my loans. I was happy to get the forgiveness. It would have made no difference to me whether or not there was a forgiveness provision. I would have become a teacher. I would have gone into the poverty areas that I went into. It would have made absolutely no difference.

And I would suggest that I would rather not mix the two at this point. And I think that when you reconsider the reauthorization of the Higher Education Act, that that might be the appropriate time. But I would prefer not to see it here.

Senator STAFFORD. Mr. Brod?

Mr. BROD. I share Dr. Smith's experience in part, because I also had such a loan. I would think it would be a useful incentive, but probably not in the current demographic situation the kind of incentive we need for encouraging individuals. And also given the salary status of the teaching profession, I wonder if it would even suffice as a useful incentive. We need much stronger incentives, I think.

Senator STAFFORD. Dr. Mehlinger.

Mr. MEHLINGER. I guess I will support the preceding statements and just add one other point. In my remarks I indicated that some States are experimenting with the same idea, and you might want to look at what—how prevalent the experiment is across the country in the States and then decide whether it is useful for the Federal Government to duplicate it.

Senator STAFFORD. Dr. Fretwell.

Mr. FRETWELL. I would like to share with you at the end of this session, if I might, and present into the record a copy of a letter which happened to have been sent to Congressman David McCurdy by Charles Saunders, vice president for governmental relations of the American Council on Education which addresses this issue, which is too long to read here, but I would like to, if I might, read two paragraphs, even though it may seem a bit disjointed.

Senator STAFFORD. Certainly.

Mr. FRETWELL. "On behalf of the Higher Education Associations listed below, we commend you for your leadership regarding efforts to resolve the current crisis in mathematics and science education. We support your introduction of H.R. 836 to permit a tax credit to certain employers that engage the services of precollege mathematics and science teachers for part-time and summer employment; however, we have a number of concerns regarding the proposal in H.R. 835 to utilize loan forgiveness as an incentive to attract undergraduate students into teaching careers of mathematics and science."

The letter goes on to state on page 2 that, "Since data are inconclusive about the effects of loan forgiveness as a mechanism to influence labor shortages, we believe that the proposed scholarship program contained in H.R. 1310 should be implemented as an experimental approach toward addressing the problem with evaluation after a decent period of time." And the rest of the details are contained in this letter, which I shall present for the record.

Thank you.

Senator STAFFORD. Thank you, Doctor. We will place the entire letter in the record.

[The letter referred to follows:]

AMERICAN COUNCIL ON EDUCATION
Division of Governmental Relations

February 18, 1983

The Honorable Dave McCurdy
U. S. House of Representatives
Washington, DC 20515

Dear Representative McCurdy:

On behalf of the higher education associations listed below, we commend you for your leadership regarding efforts to resolve the current crisis in mathematics and science education. We support your introduction of H.R. 836, to permit a tax credit to certain employers that engage the services of pre-college mathematics and science teachers for part-time and summer employment. However, we have a number of concerns regarding your proposal in H.R. 835 to utilize loan-forgiveness as an incentive to attract undergraduate students into teaching careers in mathematics and science.

As you consider modifications to H.R. 1310, now pending before the Science and Technology Committee, we respectfully request your consideration of the following observations:

- NDSL forgiveness would complicate the existing loan programs authorized under the Higher Education Act, Title IV; these are already very difficult for institutions to administer and for students to understand. Forgiveness for math and science teachers at 9 percent interest, for example, would create a fourth distinct category of NDSL loans which already have rates of 3 percent, 4 percent, and 5 percent.

- NDSL funds are not uniformly disbursed among institutions, since the amount of funds on hand at a given campus depends on the length of time the institution has participated in the program and on the institution's ability to replenish the revolving fund through its collection efforts. Further, the amount of new money for NDSLs has been reduced over the past several years, and once again has been slated for elimination.

- If the only federal loans forgiven are NDSL's there are questions raised regarding efficiency and equity. NDSL's are generally given only to very low-income students who have difficulty getting commericially viable Guaranteed Student Loans (GSL's); relatively few NDSL's are awarded compared to GSL's. Thus it would be more logical to extend forgiveness to the GSL program. Yet Congress has recently imposed cost-saving restrictions on this entitlement program, and it is unlikely that such liberalization would be seriously considered at this time.

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- In contrast to loan programs, grant or scholarship mechanisms with service provisions are intended to create an obligation for service rather than to distribute student aid. Evidence suggests that the more like a loan the assistance becomes, through the option of periodic cash payments in lieu of service, the less service is obtained.

Since data are inconclusive about the effects of loan-forgiveness as a mechanism to influence labor shortages, we believe that the proposed scholarship program contained in H.R. 1310 should be implemented as an experimental approach toward addressing this problem, and assessed for its impact after the expiration of the authority. One of the advantages of such an approach is that the size of the award and the prospect of a substantial payback obligation can be expected to provide both a greater incentive to pursue a teaching career and a greater deterrent to avoiding the service responsibility. Loan forgiveness has been presumed to afford a neglible incentive and to pose insignificant obstacles to avoiding the service responsibility.

Importantly, the proposed scholarship program has the further advantage of not increasing administrative difficulties in the existing system of student financial assistance. We believe that the reauthorization of the Higher Education Act two years from now is the appropriate occasion for discussion of any suggested alterations in the federal commitment to student aid.

This letter is on behalf of:

American Association of Colleges for Teacher Education
American Association of Community and Junior Colleges
American Association of State Colleges and Universities
American Council on Education
Council of Graduate Schools in the United States
National Asssociation of Independent Colleges and Universities
National Association of State Universities and Land-Grant Colleges

Sincerely,

Charles B Saunders Jr.

Charles B. Saunders, Jr.
Vice President for
Governmental Relations

CBS:pef

cc: Members of Science and Technology Committee

Senator **Stafford**. Reverend Byron.

Father **Byron**. I do not think it would be a sufficiently strong incentive. I think if it were to be applied at all, it should apply to all of teaching as a profession, and the reconsideration of the higher education amendments would be the place to take that up.

And it seems to me that we are getting a maldistribution now because of the debt burden that students carry. I just have a feeling that fewer students are choosing the science and humanities disciplines through Ph. D. programs and selecting, for example, law or medicine or dentistry, because of the anticipated ability to pay off their debts; not professional school debts, but their undergraduate student debts.

And if they are choosing a spouse also carrying a heavy debt burden, that just makes the matter much more complex. So as a device to meet this problem, I do not see it as being particularly useful. But I do see a misallocation of our talent in function of the debt burden, which is an argument for more grants or a GI bill type of student aid.

Senator **Stafford**. Thank you very much, sir.

Senator Pell.

Senator **Pell**. Thank you, Mr. Chairman. I have some questions I might submit for the record. I would just add the thought that what is needed here is not only the national incentive, but somehow to restore the prestige to teaching that it deserves, because the real strength of our Nation is the education of our young people, and the teachers play a role in that, and yet over the last few years their position in the community, their prestige dropped.

And I would hope that we can take some kind of measures like that honoring teachers.

Mr. **Fretwell**. Could I speak to that for a moment, Senator? A very good question Senator Pell has raised: There are a lot of answers to it, but I would suggest one, believe it or not, that does not cost significant amounts of money, necessarily, and this is what I will call "colleague ship." The bay area writing project, for example, which I think addresses one of Senator Denton's chief concerns, improving the teaching of English composition in the schools, which came out of Berkeley, Calif., but is in use extensively in our State, provides a close working relationship, not just for one course, but over a period of time, between teachers in the schools and teachers of the same subject—in that case, English—at the collegiate level.

The teachers, who are master teachers, as defined in the schools, work then with certain of their colleagues who can learn from them in the school, a mentor situation, and they in turn are, I hope, inspired, certainly helped by people in the English department in certain universities. Now, this is a relatively low-cost program, but there are some satisfactions, some prestige for an elementary schoolteacher to be working with his or her colleague at the high school level, and so on, up the line. I had this experience as a teacher in the elementary school, and being plugged into a good science teacher meant a lot to me at that time, and the school district did not spend much money on it.

Senator **Pell**. A good idea. And thank you very much.

Senator **Stafford**. Well, the Chair wants to thank you all very much, gentlemen, for your patience; we appreciate the sacrifice you have made, and we apologize for the demands of time that always seem to catch up with us here.

We really are going to study your detailed statements carefully in drafting the legislation, and for the whole subcommittee, our thanks.

Thank you very much.

The next panel will consist this morning of Mr. Gilbert D. Johnson, manager of training and education, Information Technology Group, Electronic Data Systems, Dallas, Tex., and also Dr. William Lucas, the assistant superintendant, Los Angeles School Distirct, Los Angeles, Calif., who will be an extra added attraction today. We understand, Doctor, there was apparently some mixup in the schedule—when we asked you to be here or in the airlines, we do not know which; but anyway we are delighted you are here this morning.

We still have the old bugaboo of time, gentlemen, because if we run an awful lot longer, we are going to become illegal by Senate rules. So, Mr. Johnson, we would be most happy to hear from you.

STATEMENTS OF GILBERT D. JOHNSON, MANAGER, EDUCATION AND TRAINING, INFORMATION TECHNOLOGY GROUP, ELECTRONIC DATA SYSTEMS, ACCOMPANIED BY MILTON RUSSELL, GENERAL COUNSEL, ASSOCIATION OF DATA PROCESSING SERVICE ORGANIZATIONS; AND WILLIAM LUCAS, ASSISTANT SUPERINTENDENT, LOS ANGELES UNIFIED SCHOOL DISTRICT

Mr. **Johnson**. Thank you, Mr. Chairman. I would like to introduce Mr. Milton Russell, who is the general counsel for ADPSO under whose sponsorship we are appearing here today.

Senator **Stafford**. We are very glad he is here.

Mr. **Johnson**. I am going to depart from my notes, if I may. I understand that they will be submitted for the record.

Senator **Stafford**. Sure.

Mr. **Johnson**. As you know, we are here representing industry, in particular the data processing industry. We do not consider ourselves to be educators, nor legislators, but we do appreciate the opportunity to share with you our concerns regarding present educational standards as they apply to math, science, and computer science.

Within our industry we tend to do a great deal of internal training. In my firm, EDS, we have been conducting extensive internal training programs since 1968. Because we have experienced problems with the academic qualifications of people coming into our entry-level programs, we are deeply concerned with the issues currently before this subcommittee. As an example of the basis for our concern, we currently have approximately 140 entry-level technical positions open at our local facilities. We also have approximate 1,500 applicants to fill those positions; however, because of academic qualifications, only 75 of those applicants are qualified.

By in large, the principal academic failings of unqualified applicants are the lack of a basic sounding in mathematics and science, as well as a general weakness in computer literacy. The importance of these subjects at all levels of education cannot be overemphasized. In a great many of the junior high and high schools, computers are becoming more and more prevalent. Unfortunately, our experience indicates that many of the teachers who use this equipment have received very little training other than simple operating instructions. Computer literacy throughout academia appears to be a problem.

As indicated in my written testimony, we feel that there are three basic factors that should be considered in relation to the problems you are considering. The first is that we are in the age of the computer. Almost everything in our society is influenced by computers and computer technology. This situation reinforces the need for computer literacy.

Second, academia must remain abreast of computer science. In past eras, most of the new technology has come out of academia. In the field of computer science, that new technology is now being driven by industry, and we recommend a closer association between industry and academia to close that technology loop.

And third, the computer industry needs to realize its responsibility to play an active part in closing the technology loop.

In our written testimony, we have provided seven recommenations. We do not feel that they are subject to direct legislation, but we do feel that they might be encouraged by legislative action.

[The prepared statement of Mr. Johnson follows:]

STATEMENT

OF

GILBERT D. JOHNSON

ELECTRONIC DATA SYSTEMS, INC.

MR. CHAIRMAN AND MEMBERS OF THE COMMITTEE:

MY NAME IS GILBERT D. JOHNSON, I AM THE MANAGER OF EDUCATION AND TRAINING FOR ELECTRONIC DATA SYSTEMS' (EDS) INFORMATION TECHNOLOGY GROUP.

I WANT TO THANK THE COMMITTEE FOR THIS OPPORTUNITY TO APPEAR HERE TODAY AND EXPRESS THE VIEWS OF MY COMPANY REGARDING THE PREPAREDNESS OF STUDENTS TO ENTER CAREERS IN THE TECHNICAL FIELD OF DATA PROCESSING. WHILE MY PRESENCE TODAY IS UNDER THE SPONSORSHIP OF THE ASSOCIATION OF DATA PROCESSING SERVICE ORGANIZATIONS (ADAPSO), OF WHICH EDS IS AN ACTIVE MEMBER, THE VIEWS I WILL PRESENT ARE SOLELY THOSE OF MY COMPANY AND ARE NOT NECESSARILY THOSE OF ADAPSO. MY PURPOSE TODAY IS NOT TO COMMENT DIRECTLY ON THE LEGISLATION WHICH YOU ARE CONSIDERING BUT TO SHARE WITH YOU THE NATURE AND MAGNITUDE OF THE PROBLEMS EXPERIENCED BY EDS, AS PART OF THE DATA PROCESSING INDUSTRY, IN OBTAINING QUALIFIED ENTRY-LEVEL TECHNICIANS.

EDS IS THE THIRD LARGEST FIRM IN THE DATA PROCESSING SERVICES INDUSTRY AS RANKED BY THE PERIODICAL DATAMATION. OUR PRINCIPAL BUSINESS IS TO INTERFACE BETWEEN OUR CLIENTS AND THE COMPUTER. ESSENTIALLY WE INCORPORATE THE SKILLS OF BUSINESS MANAGEMENT WITH TECHNOLOGY OF DATA PROCESSING TO SOLVE BUSINESS AND MANAGERIAL PROBLEMS. MY ROLE AS THE MANAGER OF EDUCATION AND TRAINING FOR OUR GROUP IS TO DEVELOP, PROVIDE, AND MANAGE THE MANAGERIAL, BUSINESS SKILLS, AND TECHNICAL TRAINING NECESSARY FOR OUR EMPLOYEES TO CARRY OUT THE DAY-TO-DAY BUSINESS IN AN EFFICIENT AND COST-EFFECTIVE MANNER.

EARLY IN ITS 20-YEAR HISTORY, EDS REALIZED THAT ACADEMIA SIMPLY DOES NOT, OR CANNOT, PRODUCE BUSINESS ORIENTED TECHNICIANS, AT LEAST IN THE NUMBER WE REQUIRE. IN 1968, EDS ESTABLISHED ITS OWN INTERNAL TRAINING ARM WHICH TODAY PROVIDES TRAINING FOR MANAGERS, COMPUTER OPERATORS, AND SYSTEMS ENGINEERS. WHILE ALL OF THESE TRAINING PROGRAMS ARE IMPORTANT TO US, PERHAPS THE SYSTEMS ENGINEERING DEVELOPMENT PROGRAM IS THE MOST CRITICAL AND MOST ACCURATELY PORTRAYS THE DIFFICULTIES WE EXPERIENCE DUE TO THE PAUCITY OF WELL PREPARED STUDENTS ENTERING OUR JOB FORCE. TO APPRECIATE THE IMPORTANCE OF THIS PROGRAM TO EDS, YOU MUST UNDERSTAND THAT THERE ARE SIMPLY NOT ENOUGH PROGRAMMERS AND SYSTEM ANALYSTS AVAILABLE IN THE JOB MARKET TO MEET THE NEEDS OF OUR INDUSTRY. AS A RESULT, IT IS IMPERATIVE THAT WE DEVELOP THEM OURSELVES. WE DO THIS THROUGH OUR SYSTEMS ENGINEERING DEVELOPEMENT PROGRAM.

THE PURPOSE OF THE SYSTEMS ENGINEERING DEVELOPMENT (SED) PROGRAM IS TO PROVIDE QUALIFIED SYSTEMS ENGINEERS (SE) FOR EDS. THIS IS AN ENTRY-LEVEL PROGRAM WHICH TAKES OUTSTANDING INDIVIDUALS WHO HAVE DEMONSTRATED THE QUALITIES

OF LEADERSHIP, AGGRESSIVENESS, SELF-CONFIDENCE, AND COMPETITIVENESS AND DEVELOPS THEM INTO GOOD BUSINESSMEN OR OR WOMEN WHO ARE ALSO HIGHLY SKILLED IN DATA PROCESSING TECHNIQUES. PARTICIPANTS IN THIS PROGRAM ARE COMMONLY REFERRED TO AS "SEDS."

A NEW SED WILL GO THROUGH THREE PHASES IN THE COURSE OF THIS DEVELOPMENT PROGRAM:

PHASE I: IN PHASE I, THE SED IS ASSIGNED TO AN EDS ACCOUNT WORKING WITH QUALIFIED SEs AND THE CUSTOMER'S MANAGEMENT AND CLERICAL STAFF. THE GOAL OF THIS PHASE IS TO FAMILIARIZE THE SED WITH THE BUSINESS ASPECTS OF DATA PROCESSING. THE PHASE I SED WILL HAVE RECEIVED NO PRIOR TECHNICAL TRAINING IN EDS BUT THROUGH ON-THE-JOB TRAINING WILL LEARN THE CUSTOMER'S BUSINESS AND EDS' SYSTEM WELL ENOUGH TO HELP THE CUSTOMER TRAIN HIS OWN PERSONNEL IN THE USE OF THE SYSTEM. THE SED MUST STRIVE TO UNDERSTAND THE CUSTOMER'S PROBLEMS WELL ENOUGH TO EXPLAIN THEM TO AND WORK WITH EXPERIENCED SEs TO RESOLVE THEM. DEPENDING UPON THE INDIVIDUAL, PHASE I MAY LAST FROM SIX MONTHS TO ONE YEAR.

PHASE II: DURING PHASE II, THE SED ATTENDS SIX WEEKS OF INTENSIVE FORMAL TRAINING IN COMPUTER PROGRAMMING AND SYSTEMS DESIGN. THIS TRAINING IS EXTREMELY DEMANDING AND REQUIRES AN AVERAGE OF TEN TO TWELVE HOURS PARTICIPATION PER DAY, SIX DAYS A WEEK, FOR THE ENTIRE PERIOD.

Phase III: Upon successful completion of Phase II, the SED returns to an EDS account. The III SED combines the business skills achieved during Phase I with the technical skills achieved during Phase II, and functions as a novice Systems Engineer. Initially, this involves extensive programming; either maintaining existing programs or writing new ones. In time, based on demonstrated professional knowledge, understanding and productivity, the SED proceeds to more technically sophisticated system design and programming responsibilities.

An SED normally completes the entire program within an 18 to 24 month time frame. To be considered a qualified Systems Engineer, the SED must have a thorough understanding of EDS' concept of doing business, be thoroughly familiar with a customer's business, and have achieved measured results in a technical area.

The SED Program, as I have outlined for you, and our similar managerial and computer operator programs, work very well for us. The problem, and the key point of my testimony, is the quality and preparedness of young men and women to enter a technical career of this type.

The profile of an average successful SED candidate would be a college graduate who has a technically-related degree in mathematics, engineering, one of the hard sciences, OR A BUSINESS-RELATED DEGREE SUCH AS ACCOUNTING OR BUSINESS ADMINISTRATION. THE CANDIDATE WILL HAVE AT LEAST A 3.2 GRADE POINT AVERAGE, ALONG WITH A PERSONAL HISTORY WHICH WILL INCLUDE INDICATIONS OF LEADERSHIP, AGGRESSIVENESS IN THE PURSUIT OF PERSONAL GOALS, AND THE ABILITY TO THINK THROUGH INTRICATE PROBLEMS. ANOTHER IMPORTANT INGREDIENT WILL BE AN INDICATION OF GOOD ORAL AND WRITTEN COMMUNICATION SKILLS.

WHILE THIS PROFILE MAY APPEAR TO BE OPTIMISTIC TO YOU, OUR EXPERIENCE IS THAT THESE ARE GENERALLY THE MINIMAL REQUIREMENTS TO SUCCEED IN OUR INDUSTRY. UNFORTUNATELY, EDUCATIONAL INSTITUTIONS SIMPLY DO NOT PRODUCE GRADUATES WITH THESE SKILLS IN THE QUANTITIES NECESSARY TO STAFF OUR INDUSTRY. FOR EXAMPLE, IN MY OWN EDS GROUP THERE ARE OVER 140 TECHNICAL POSITIONS OPEN. OUR ACTIVE APPLICANT FILES NUMBER APPROXIMATELY 1,500 AND OF THAT NUMBER ONLY 75 ARE CLEARLY QUALIFIED FOR ONE OF OUR POSITIONS. THERE IS NO REASON TO BELIEVE THAT THIS SITUATION WILL IMPROVE IN THE NEAR FUTURE. PERHAPS THE OVERALL MAGNITUDE OF THIS PROBLEM WITHIN THE ENTIRE DATA PROCESSING INDUSTRY IS BEST REVEALED BY THE PROJECTION OF THE OCCUPATIONAL OUTLOOK SECTION OF THE U.S. DEPARTMENT OF LABOR WHICH REPORTS THAT THERE WILL BE AN AVERAGE ADDITIONAL NEED FOR 36,000 TO 40,000 COMPUTER PROGRAMMERS EACH YEAR

BETWEEN NOW AND 1990. PLEASE NOTE THAT THIS PROJECTION APPLIES ONLY TO COMPUTER PROGRAMMERS AND DOES NOT INCLUDE ANY OF THE OTHER TECHNICAL JOB CATEGORIES NORMALLY CONSIDERED PART OF THE DATA PROCESSING INDUSTRY SUCH AS COMPUTER OPERATORS, SYSTEMS ANALYSTS, ETC.

THE PRINCIPAL ACADEMIC REASONS MOST APPLICANTS FAIL TO MEET OUR EMPLOYMENT STANDARDS FOR ENTRY-LEVEL TECHNICAL POSITIONS ARE LOW GRADES, A WEAK BACKGROUND IN THE BASICS OF MATHEMATICS AND GENERAL SCIENCE, AND LITTLE, IF ANY, DATA PROCESSING RELATED COURSE WORK. EVEN AFTER WE HAVE HIRED CANDIDATES WHO APPEAR TO MEET OUR STANDARDS, WE ARE OFTEN DISAPPOINTED BY THEIR INABILITY TO APPLY SIMPLE LOGIC AND REASONING TO THE PROBLEM SOLVING PROCESS AND, MORE OFTEN THAN NOT, THEY HAVE POOR WRITTEN COMMUNICATION SKILLS. OTHER AREAS THAT CONCERN US DEEPLY ARE THE NUMBER OF TIMES COLLEGES AND UNIVERSITIES PERMIT A STUDENT TO RETAKE OR WITHDRAW FROM TRADITIONAL MATH AND SCIENCE COURSES IN WHICH THEY ARE DOING POORLY, AND THE APPARENTLY UNINFORMED ADVICE THAT SCHOOL COUNSELORS PROVIDE STUDENTS REGARDING THE DATA PROCESSING INDUSTRY.

IN OUR OPINION, IT MAY VERY WELL BE THAT LACK OF COMPUTER LITERACY, ESPECIALLY IN ACADEMIA, IS AN OVERALL FACTOR IN THE NATURE OF THE PROBLEMS WE EXPERIENCE WITH RECENT GRADUATES. MICROCOMPUTERS ARE BECOMING MORE AND MORE COMMON IN GRAMMAR, JUNIOR HIGH AND HIGH SCHOOLS, YET APPARENTLY FEW OF THE TEACHERS WHO INSTRUCT STUDENTS IN THE USE OF THESE TOOLS AND THE THEORIES BEHIND THEM HAVE RECEIVED ANYTHING BEYOND FAMILIARITY TRAINING IN THE OPERATION OF THE EQUIPMENT; FEWER STILL HAVE EVER USED THEM TO PERFORM ANY PRACTICAL TASKS. ALMOST EVERY COLLEGE OR UNIVERSITY IN THE UNITED STATES OWNS, OR HAS ACCESS TO, LARGE MAIN FRAMES AND SYSTEMS WHICH ARE USED IN THE ADMINISTRATION OF THE INSTITUTION AS WELL AS FOR INSTRUCTIONAL PURPOSES IN DATA PROCESSING OR COMPUTER SCIENCE DEPARTMENTS. HOWEVER, FROM OUR PERSPECTIVE, IT APPEARS THAT A LARGE NUMBER OF THE INSTRUCTORS AND PROFESSORS WHO TEACH IN THESE DEPARTMENTS HAVE LITTLE PRACTICAL EXPERIENCE IN THE TOPICS THEY TEACH. AS A RESULT, GRADUATES HAVE ONLY CONCEPTUAL OR THEORETICAL BACKGROUNDS WHEN THEY COME TO INDUSTRY AND FEW HAVE ANY SKILLS THAT THEY CAN IMMEDIATELY APPLY. TO EMPHASIZE THIS POINT, GENERALLY SOMEONE WHO HAS THE PROFILE I OUTLINED PREVIOUSLY BUT WHO HAS ALSO ATTENDED A COURSE AT ONE OF THE DATA PROCESSING TECHNICAL INSTITUTES IS A MUCH MORE ACCEPTABLE APPLICANT SIMPLY BECAUSE OF THE MORE PRAGMATIC SKILL APPROACH TAKEN BY THE TECHNICAL INSTITUTES.

IN MY OPINION, ANY SOLUTION TO THE PROBLEMS I HAVE TOUCHED ON TODAY MUST CLEARLY RECOGNIZE THREE FACTORS. FIRST, WE ARE IN THE AGE OF THE COMPUTER. NOTHING IS SO PERVASIVE IN OUR SOCIETY TODAY, OR IN OUR PERSONAL LIVES, AS THE COMPUTER. IT IMPACTS VIRTUALLY EVERYONE OF US NO MATTER WHAT OUR STATION MAY BE. SECOND, ACADEMIA MUST REMAIN ABREAST OF COMPUTER AND RELATED TECHNOLOGY. IN PREVIOUS ERAS OUR COLLEGES AND UNIVERSITIES WERE DEEPLY INVOLVED IN, IF NOT THE SOURCE OF, MUCH OF OUR TECHNOLOGICAL ADVANCEMENT; HOWEVER, IN THE FIELD OF COMPUTER SCIENCE THAT ADVANCEMENT IS NOW CLEARLY DRIVEN BY INDUSTRY. AS A RESULT, OUR ACADEMIC INSTITUTIONS ARE OUT OF STEP WITH THE REAL WORLD FOR WHICH THEY ARE ATTEMPTING TO PREPARE THEIR STUDENTS. THIRD, THE COMPUTER INDUSTRY IN GENERAL MUST BE WILLING AND AVAILABLE TO CLOSE THE TECHNOLOGY LOOP BETWEEN ITSELF AND ACADEMIA.

WHEN APPLIED TO THE PROBLEM AT HAND, THESE FACTORS WOULD SUGGEST ACTION IN THE FOLLOWING AREAS:

(1) ACADEMIA MUST REAFFIRM AND REEMPHASIZE BASIC MATHEMATIC AND SCIENTIFIC SKILLS AT ALL LEVELS. VIRTUALLY NO HIGH SCHOOL OR COLLEGE CURRICULUM SHOULD PERMIT STUDENTS TO "OPT OUT" OF THIS INSTRUCTION.

(2) ACADEMIA SHOULD AGGRESSIVELY PURSUE THE ACTIVE PARTICIPATION OF INDUSTRY IN DETERMINING CURRICULUM CONTENT FOR COMPUTER SCIENCE/DATA PROCESSING PROGRAMS.

(3) ACADEMIA SHOULD REQUIRE COMPUTER LITERACY INSTRUCTION IN ALL CURRICULA TO THE EXTENT

THAT EACH FIELD OF STUDY EMPLOYS COMPUTERS IN THE PRACTICE OF ITS ENDEAVORS.

(4) WHERE APPLICABLE. COMPUTER LITERACY SHOULD BE CONSIDERED A QUALIFYING FACTOR FOR TEACHERS.

(5) ACADEMIA SHOULD USE CURRENT AND RETIRED INDUSTRY REPRESENTATIVES AS VISITING OR PARTICIPATORY INSTRUCTORS IN COMPUTER SCIENCE/DATA PROCESSING PROGRAMS AS WELL AS IN ANY OTHER FIELD OF STUDY THAT RELIES ON COMPUTER TECHNOLOGY.

(6) A MEANS FOR INDUSTRY TO SHARE ITS TECHNOLOGY MORE OPENLY WITH ACADEMIA NEEDS TO BE ENCOURAGED.

(7) WHERE FEASIBLE, INDUSTRY SHOULD CONSIDER INVITING ACADEMIA TO PARTICIPATE MORE CLOSELY IN THE BUSINESS AND TECHNICAL ASPECTS OF COMPUTER SCIENCE/DATA PROCESSING.

THESE SUGGESTIONS ARE ONLY A BEGINNING, BUT I THINK THEY CAN LEAD TO A MUTUALLY BENEFICIAL RELATIONSHIP BETWEEN ACADEMIA AND INDUSTRY. IN AND OF THEMSELVES, THEY ARE NOT SUBJECT TO IMPLEMENTATION BY LEGISLATION, BUT CERTAINLY THEY LEND THEMSELVES TO LEGISLATIVE ENCOURAGEMENT.

IN CLOSING, MR. CHAIRMAN, I WOULD LIKE TO ASSURE YOU NONE OF THE STATEMENTS I HAVE MADE TODAY HAVE BEEN INTENDED AS AN ATTACK ON ACADEMIA, OR TO IN ANY WAY DETRACT FROM THE DEDICATION, PERFORMANCE, AND PERSEVERANCE OF THE TEACHING PROFESSION TO WHICH WE ARE ALL INDEBTED. THE IMPORTANCE OF PROVIDING OUR YOUNG MEN AND WOMEN WITH A WELL ROUNDED EDUCATION THAT ADEQUATELY PREPARES THEM TO BE EFFECTIVE AND USEFUL MEMBERS OF OUR SOCIETY CANNOT BE OVEREMPHASIZED. TO THE END, I APPLAUD THE EFFORTS OF YOU AND THE MEMBERS OF THIS SUBCOMMITTEE.

Senator **Stafford**. Well, thank you very much, Mr. Johnson.

Mr. Lucas, we would be glad to hear from you.

Mr. **Lucas**. Thank you, Mr. Chairman. I am actually wearing three hats. I would like to represent the American Association of School Administrators, as well as the Los Angeles Unified School District and I would like to submit for the record testimony for the Council of Great City Schools that was to be given by Floretta Mackenzie, superintendent of schools in Washington, D.C.

Senator **Stafford**. Without objection, we will make that a part of the hearing record.

[Material referred to follows:]

STATEMENT BY:

DR. HARRY HANDLER
SUPERINTENDENT
LOS ANGELES UNIFIED SCHOOL DISTRICT

PRESENTED TO:

SENATE SUB-COMMITTEE ON EDUCATION, ARTS
AND HUMANITIES
UNITED STATES CONGRESS
MARCH 9, 1983

MR. CHAIRMAN AND MEMBERS OF THE COMMITTEE ....

MY NAME IS HARRY HANDLER, SUPERINTENDENT OF THE LOS ANGELES UNIFIED SCHOOL DISTRICT. I APPRECIATE THE INVITATION TO APPEAR BEFORE YOU AND PRESENT REMARKS ON AN ISSUE OF VITAL IMPORTANCE TO THE FUTURE OF OUR NATION--THE EDUCATION OF OUR YOUNG PEOPLE IN THE AREAS OF MATHEMATICS AND SCIENCE.

THE DISTRICT WHICH I REPRESENT--THE LOS ANGELES UNIFIED SCHOOL DISTRICT--IS THE NATION'S SECOND LARGEST SCHOOL SYSTEM. IT COVERS AN AREA OF 710 SQUARE MILES, IN WHICH LIVE MORE THAN 3.5 MILLION PEOPLE. OUR SCHOOL DISTRICT ENROLLMENT, FROM KINDERGARTEN THROUGH THE TWELFTH GRADE, TOTALS MORE THAN 500,000 PUPILS, WITH ANOTHER 100,000 STUDENTS SERVED IN ADULT EDUCATION PROGRAMS.

THE DISTRICT SERVES A DIVERSE POPULATION. OUR STUDENT RACIAL AND ETHNIC COMPOSITION FOR THIS SCHOOL YEAR CONSISTS OF .35% AMERICAN INDIAN, 7.5% ASIAN/FILIPINO, 21.39% BLACK, 48.93% HISPANIC AND 21.76% NON-HISPANIC WHITE. WE ARE ONE OF 1200 SCHOOL DISTRICTS IN CALIFORNIA, YET WE EDUCATE NEARLY 14 PERCENT OF ALL STUDENTS IN THE STATE.

IN THE AREAS OF SCIENCE AND MATHEMATICS EDUCATION, THE PROBLEMS NOW CLEARLY EVIDENT THROUGHOUT OUR LAND LEAVE US WITH A SERIOUS AND CRITICAL QUESTION: WILL THE PUBLIC SCHOOLS OF OUR NATION BE ABLE TO PREPARE THE SCIENTIFIC, ENGINEERING, AND TECHNICAL PERSONNEL TO MAINTAIN OUR POSITION AS A LEADER AMONG THE NATIONS OF THE WORLD?

SPUTNIK IGNITED THE LAST CRISIS IN EDUCATION IN THE 1950s. WILL IT TAKE ANOTHER SPUTNIK-LIKE FUROR TO FORCE US, AS A NATION, TO RECOGNIZE THAT PUBLIC EDUCATION IS IN TROUBLE, AND ESPECIALLY SO IN SCIENCE AND MATHEMATICS INSTRUCTION?

OF OUR 30,000 CERTIFICATED EMPLOYEES, 1,500 ARE MATHEMATICS TEACHERS, OF WHOM 508 HAVE EMERGENCY TEACHING CREDENTIALS. FOUR HUNDRED

FIFTY-TWO ARE SCIENCE TEACHERS, 90 OF THEM SERVING WITH EMERGENCY CREDENTIALS. THE EMERGENCY CREDENTIAL IS A SPECIAL CALIFORNIA PROVISION FOR PERSONS WHO HAVE GRADUATED FROM A COLLEGE OR UNIVERSITY WITH A BACCALAUREATE OR HIGHER DEGREE, BUT HAVE NOT FULFILLED OTHER REQUIREMENTS FOR THE CREDENTIAL.

BASED ON CURRENT CURRICULUM REQUIREMENTS, WE WILL NEED APPROXIMATELY 254 NEW MATHEMATICS TEACHERS FOR THE NEXT SCHOOL YEAR. ON THE OTHER HAND, THE GROWING NATIONAL CONCERN IS ENCOURAGING SCHOOL DISTRICTS, STATE BOARDS OF EDUCATION, STATE SUPERINTENDENTS, AND STATE LEGISLATURES TO CONSIDER MODIFYING CERTAIN CURRICULUM REQUIREMENTS.

CALIFORNIA'S STATE BOARD OF EDUCATION IS ENCOURAGING NEW STANDARDS THAT COULD REQUIRE OUR DISTRICT TO OFFER STUDENTS AN ADDITIONAL YEAR AND ONE-HALF OF MATHEMATICS BEFORE GRADUATION. THIS ADDITIONAL REQUIREMENT, AS DESIRABLE AS IT IS, WILL CALL FOR 124 MORE FULL-TIME TEACHERS WHO MUST BE QUALIFIED TO TEACH THE APPROPRIATE MATHEMATICS COURSES. THE STATE SUPERINTENDENT IS ALSO SUGGESTING A NEW FOCUS ON COMPUTER LITERACY. GENERALLY, MATHEMATICS TEACHERS ARE CALLED ON TO TEACH THESE COURSES. WE WILL NEED A MINIMUM OF 280 FULL-TIME

TEACHERS WHO ARE QUALIFIED TO TEACH SUCH COURSES, IF ALL STUDENTS ARE REQUIRED TO TAKE THEM BEFORE GRADUATION.

IF THESE NEW ADDITIONS TO THE CURRICULUM ARE INITIATED BY OUR STATE LEGISLATURE, THE LOS ANGELES UNIFIED SCHOOL DISTRICT WOULD NEED MORE THAN 404 NEW MATHEMATICS TEACHERS, IN ADDITION TO THE 254 NEEDED TO CONTINUE THE CURRENT CURRICULUM, FOR A TOTAL EXCEEDING 658.

WHAT ABOUT THE SUPPLY OF AVAILABLE TEACHERS? OUR MAJOR SOURCE OF NEW TEACHERS HAS BEEN LOCAL COLLEGES AND UNIVERSITIES. IN 1972, WE INTERVIEWED 1,700 ASPIRING TEACHERS AT THESE LOCAL INSTITUTIONS. LAST YEAR, ONLY 300 ASPIRANTS WERE INTERVIEWED, AND ONLY 3 OF THESE WERE QUALIFIED TO BE MATHEMATICS TEACHERS.

LAST YEAR THE UNIVERSITY OF CALIFORNIA AT BERKELEY HAD ONLY FIVE PEOPLE TRAINING TO BE SCIENCE TEACHERS AND ONE STUDENT PREPARING TO BE A SECONDARY SCHOOL MATH INSTRUCTOR. AT UCLA, THE NUMBERS WERE NINE IN SCIENCE AND SIX IN MATH. THE TOTAL NUMBER OF SCIENCE

TEACHERS IN TRAINING AT THE EIGHT UC CAMPUSES AND THE UNIVERSITY OF CALIFORNIA WAS 47. THE COMPARABLE FIGURE FOR MATH WAS 22.

CLEARLY, WE MUST LAUNCH AGGRESSIVE PROGRAMS TO MAKE TEACHING ATTRACTIVE TO YOUNG PEOPLE NOW IN OUR COLLEGES. THE PRIMARY AREA WE NEED TO CONSIDER IS HOW WE REWARD AND RECOGNIZE PEOPLE IN THE TEACHING PROFESSION.

FOR EXAMPLE, SOMEONE WHO IS A MATHEMATICS, PHYSICS, OR SOME KIND OF SCIENCE MAJOR FOR FOUR YEARS AND WHO THEN HAS A FIFTH YEAR OF TRAINING, AS A TEACHER CREDENTIAL IN CALIFORNIA GENERALLY REQUIRES, CAN EARN A STARTING SALARY IN AEROSPACE OR RELATED INDUSTRIES OF AT LEAST $20,000.

OUR BEGINNING TEACHERS ARE PAID $13,500 AND ONLY AFTER SEVERAL YEARS OF SERVICE AND ADVANCED TRAINING WILL THEY REACH THE AVERAGE OF $24,000.

A SECOND CONCERN RELATES TO THE ISSUE OF "HOW ARE WE TEACHING?" ARE STUDENTS NOT ENROLLING IN MATHEMATICS AND SCIENCE COURSES BECAUSE

THEY FIND THEM DULL AND BORING AND MAYBE EVEN THREATENING?

AS A FORMER HIGH SCHOOL MATHEMATICS TEACHER, I BELIEVE THAT SUBJECT MATTER CAN BE PRESENTED IN AN EXCITING AND CHALLENGING MANNER. TO DO SO, HOWEVER, REQUIRES EXTENSIVE RETRAINING OF OUR TEACHING PERSONNEL.

YOU WILL RECALL THE NATIONAL SCIENCE FOUNDATION AND NATIONAL DEFENSE EDUCATION ACT INSTITUTES. THESE INSTITUTES PROVIDED TEACHERS WITH AN OPPORTUNITY TO EARN A STIPEND, IN ADDITION TO PARTICIPATING IN IMPORTANT INSERVICE TRAINING. I VERY MUCH ENCOURAGE YOUR MAINTAINING AND SUFFICIENTLY FUNDING THIS PROJECT, WHICH HAS BEEN INCLUDED IN THE CURRENTLY PROPOSED EMERGENCY MATHEMATICS AND SCIENCE EDUCATION ACT, H.R. 1310.

ANOTHER OPPORTUNITY FOR UPGRADING MATH AND SCIENCE TEACHERS COULD BE THROUGH THE ESTABLISHMENT OF REGIONAL MATH AND SCIENCE DEMONSTRATION CENTERS SERVING ONE OR MORE SCHOOL DISTRICTS, COUNTIES, OR ENTIRE STATES, ACCORDING TO SCHOOL ENROLLMENT. THERE MIGHT BE ONE CENTER

FOR EACH 50,000 STUDENTS, BUT NO FEWER THAN ONE PER STATE. THESE DEMONSTRATION CENTERS WOULD BE ABLE TO PROVIDE TRAINING SESSIONS FOR TEACHERS AS WELL AS MAKE AVAILABLE RESOURCE PERSONS TO SCHOOL DISTRICTS.

IN ADDITION TO TRAINING STIPENDS, A STIPEND MIGHT BE EARNED BY TEACHERS WHO TAKE SHORTAGE-AREA COLLEGE COURSES. SPECIAL FEDERALLY SUBSIDIZED SUMMER SCHOOLS COULD ALSO BE MADE AVAILABLE FOR STUDENTS, AND PROVIDE SUMMER EMPLOYMENT FOR TEACHERS. OPPORTUNITIES FOR TEACHER SUMMER EMPLOYMENT IN INDUSTRY MIGHT BE ENCOURAGED. ADDITIONALLY, TEACHERS WHO TEACH IN SHORTAGE-AREA FIELDS MIGHT BE GIVEN FIRST PREFERENCE FOR SUMMER EMPLOYMENT IN COMPANIES THAT HAVE FEDERAL CONTRACTS.

THE FINAL AREA OF CONCERN RELATES TO "WHAT" AND "HOW MUCH" WE ARE TEACHING. IN MY STATE OF CALIFORNIA, THERE IS A CONCERTED MOVEMENT TO INCREASE THE AMOUNT OF INSTRUCTIONAL TIME PER DAY; THE LENGTH OF THE SCHOOL YEAR; AND THE NUMBER OF COURSES IN MATHEMATICS, SCIENCE, AND COMPUTER LITERACY WHICH A STUDENT MUST TAKE IN ORDER TO GRADUATE.

I BELIEVE IN INCREASING OUR REQUIREMENTS. CLEARLY, WE CANNOT TEACH YOUNG PEOPLE ANYTHING IF THEY ARE NOT IN THE CLASSROOM. SO, I SUBSCRIBE TO MORE INTENSIVE INSTRUCTION AND INCREASED INSTRUCTIONAL TIME FOR STUDENTS.

HOWEVER, I BELIEVE WE MUST LOOK CLOSELY AT HOW WE USE THIS TIME SO THAT IT CAN BE EFFECTIVELY USED. WE MUST BE CAREFUL NOT TO LOCK OURSELVES IN TO RIGID, RESTRICTIVE, AND INFLEXIBLE APPROACHES THAT FALL SHORT OF MEETING THE NEEDS OF STUDENTS.

FURTHER, I BELIEVE WE NEED TO CONSIDER THE REALITIES OF SCHOOL FINANCE, TEACHER AVAILABILITY, AND THE FACTS OF COLLECTIVE BARGAINING PROCEDURES AS WE MOVE TO RESTRUCTURE AND IMPROVE INSTRUCTION IN SCIENCE AND MATHEMATICS. TO PUT IT ANOTHER WAY, WE MUST PROVIDE EQUAL ACCESS TO HIGHLY QUALIFIED INSTRUCTION FOR ALL OF OUR STUDENTS.

FIANLLY, I WOULD SUGGEST THAT WE CONSIDER WAYS IN WHICH WE CAN COMBINE RESOURCES NOW AT HAND, WITH NEW RESOURCES TO RESTRUCTURE THE NATURE OF OUR PROGRAMS.

I OFFER ONE ADDITIONAL SUGGESTION:

BECAUSE OF FINANCIAL SHORTAGES, MOST URBAN SCHOOL DISTRICTS HAVE BEEN FORCED TO ELIMINATE WHAT WERE ONCE LARGE AND PRODUCTIVE SUMMER SCHOOL PROGRAMS. IN CALIFORNIA, MOST SCHOOL DISTRICTS OFFER ONLY A LIMITED SUMMER SCHOOL PROGRAM FOR REMEDIAL STUDENTS WHO MUST MAKE UP WORK NOT PERFORMED SUCCESSFULLY DURING THE REGULAR SCHOOL YEAR.

MY FIRST APPROACH WOULD BE TO USE FEDERAL OR STATE FUNDS TO PROVIDE A LIMITED RETURN OF THE REGULAR SUMMER SCHOOL PROGRAMS IN MATH, SCIENCE AND COMPUTER TECHNOLOGY OPEN TO ALL INTERESTED STUDENTS. THE ADDITION OF NON-REMEDIAL SUMMER SCHOOL CLASSES IN MATH, SCIENCE AND COMPUTER TECHNOLOGY SEEMS LIKE A REASONABLE METHOD TO PROVIDE THE NEEDED EDUCATIONAL OPPORTUNITIES FOR STUDENTS IN THESE VITAL AREAS. MOREOVER, SUCH AN APPROACH HAS THE FOLLOWING ADVANTAGES:

1) IT WOULD PROVIDE ECONOMIC INCENTIVES FOR TEACHERS TO ENTER AND REMAIN IN THE TEACHING PROFESSION BECAUSE IT WOULD

GUARANTEE MATH, SCIENCE AND COMPUTER SCIENCE TEACHERS A FULL YEAR'S EMPLOYMENT.

2) IT WOULD IMMEDIATELY INCREASE THE NUMBER OF STUDENTS EACH YEAR WHO CAN RECEIVE INSTRUCTION IN THESE AREAS BY 20 TO 40 PERCENT WITHOUT HAVING TO WAIT FOR LARGE NUMBERS OF ADDITIONAL QUALIFIED TEACHERS TO ENTER THE PROFESSION.

I AM CERTAIN OTHER APPROACHES CAN BE IDENTIFIED WHICH WILL PROVIDE SOME SHORT-RANGE SOLUTIONS. THE LONG-RANGE SOLUTIONS WILL BE DEPENDENT UPON OUR WILLINGNESS TO ACKNOWLEDGE THAT AN INVESTMENT IN PUBLIC EDUCATION IS ALSO AN INVESTMENT IN NATIONAL DEFENSE.

Mr. **Lucas**. I have had the privilege of hearing the previous testimony from the Secretary, until the present moment. My district, Los Angeles Unified School District really has no new ideas to offer the committee. It is in consort with the efforts of the committee. I am pleased that it is recognized by the committee that there is certainly an urgent need on the part of local school districts to provide the type of education that can equip students for tomorrow's world.

I would like to submit for the record, though, to the current problem we are facing in the Los Angeles Unified School District as far as the quantity and quality of mathematics teachers are concerned.

Of our 30,000 certificated employees, 1,500 are mathematics teachers, of whom 508 have emergency teaching credentials. 452 are science teachers; 90 of them serving on emergency credentials.

Based on current curriculum requirements, because of attrition, we will need approximately 254 new mathematics teachers in the next school year. Additionally the growing national concern is encouraging school districts, State boards of education, State superintendents, State legislators to consider modifying certain curriculum requirements which could increase this requirement.

The Secretary in his testimony highlighted California's efforts there, the State—California State Board of Education. It is encouraging new standards that would require our district to offer students an additional year and a half of mathematics before graduation.

This additional requirement, as desirable as it is, will call for 124 more full-time teachers who must be qualified to teach the appropriate mathematics courses. Our new State superintendent, Bill Hoenig, is also suggesting a new focus on computer literacy. Generally, mathematics teachers are called on to teach these courses.

We will need a minimum of 280 full-time teachers who are qualified to teach such courses if all the students are required to take them before graduation. If these new additions to the curriculum are approved by our State board of education, the Los Angeles Unified School District would need more than 404 new mathematics teachers in addition to the 254 needed to continue current curriculum, offerings for a total of 658. That is this coming September.

What about the supply of available teachers? Our major source of new teachers has been local colleges and universities. In 1972 we interviewed 1,700 aspiring teachers at these local institutions. These are institutions that by and large are located within the confines of our school district. Last year only 300 aspirants were interviewed. And only three of these were qualified to be mathematics teachers.

Last year the University of California at Berkeley had only five people trained to be science teachers, and one student preparing to be a secondary school math instructor; at UCLA, the numbers were nine in science, six in math. The total number of science teachers in training at 8 UC campuses in the University of California is 47. The comparable figure for math was 72. I think that this gives the subcommittee a pretty good idea of what the impact is on a local district.

The concept of business and education working together has been recognized for many years in California. There is in California the business-education roundtable.

It is made up of the 83 largest corporations in the State of California. Their CEO's meet with the superintendents and the public educators in California, discussing, planning, identifying problems within the public educational system in California. We do have some recommendations that this business-education roundtable has made that are directed toward a solution that we are all seeking.

I will see that that is submitted for the record also.

Thank you.

Senator **Stafford**. Thank you very much, Dr. Lucas. And thank you, Mr. Johnson. I would just note in passing that one of the purposes of the legislation proposed by Senator Pell and myself, in addition to science and mathematics, is computer technology, along with languages, as the four areas of principal focus.

To both of you, if that is agreeable, the subcommittee would like to submit some questions for responses in writing. We had some aimed at you, Dr. Lucas, for yesterday, but we will see you get them anyway.

Mr. **Lucas**. Sorry we had that mixup.

Senator **Stafford**. All right.

Is that agreeable with you, Mr. Johnson, if we do that?

Mr. **Johnson**. Yes, that is fine.

Senator **Stafford**. All right. May I, for the committee, tell you how grateful we are for your willingness to come here and counsel with us as we embark on this serious job. Thank you very much.

At this point we will include additional material subsequently supplied for the record.

nea

GOVERNMENT RELATIONS
LINDA TARR-WHELAN, Director

NATIONAL EDUCATION ASSOCIATION • 1201 16th St., N.W., Washington D C 20036 • (202) 822-7300
WILLARD H. McGUIRE, President
BERNIE FREITAG, Vice President
MARY HATWOOD FUTRELL, Secretary-Treasurer
TERRY HERNDON, Executive Director

March 22, 1983

Mr. David Morse
Subcommittee on Education, Arts
and Humanities
United States Senate
Washington, D.C. 20510

Dear David:

I am responding to the request of Senator Stafford for information from our President, Willard McGuire.

The questions and responses are enclosed.

Please do not hesitate to call for any additional information you may need.

Sincerely,

Jim

James W. Green
Manager for Legislation

JWG/sb

Enclosure

1. Are there any potential pitfalls in a comprehensive federal math and science education initiative?

   Response - Yes, one of the potential pitfalls has to do with differential pay for math and science teachers. This would interfere with negotiated salary schedules established by collective bargaining and send a signal that math and science teachers are the only contributors to success in math and science. A second pitfall could come as a result of opening the secondary classrooms to representatives of business and industry (scientists, chemists, etc.) not qualified to work with youth, i.e. not certified by state authority. A third, a funding level that will be inadequate to accomplish the task. Fourth, omitting the involvement of professional educators (teachers) in planning and implementation of the program at the local level.

2. Do we neglect other essential subjects if we make a particular effort in these discrete subject areas?

   Response - Yes, but the question is not one of neglect, but one of failure to recognize that the math and science effort is dependent upon the product of elementary school faculty, the degree of skill reached in communications, and the efforts of guidance counselors in directing students into these fields. Education needs to attract and retain quality graduates in all subject matter areas.

3. At the $500 million level of funding, do we seriously dilute our effort if we require funds to be passed through to all school districts within a state?

   Response - To address this problem one needs to look at the situation. The problem rests with the local school district. Some districts do not have qualified teachers, some require only one course in math and one in science for graduation, some districts do not offer advanced math at the secondary level, some districts have an inadequate elementary program, etc., etc. We are of the opinion that as a first step it is important to assess the needs at the local district level and devise a plan to meet those needs. Due to an inadequate availability of funds, this may require working with other school districts and institutions of higher education serving the area. Once these factors are considered, it is obvious that local districts not receiving funds from the state would be discriminated against. The problem lends itself to both a short and long range solution. In the near term the use of teacher centers and summer institutes in preparation of qualified teachers by offering math and science courses appears as a potential solution. In the longer term we must address standards, curriculum, teacher availability, and additional funding as items of need.

4. Are there learning programs for gifted students, magnet schools, programs targeted at special populations that should be incorporated into a legislative proposal?

   Response - Our main concern in response to this question is that no segment of the population be discriminated against as a result of our increased emphasis in the field of math and science.

HARVARD UNIVERSITY
GRADUATE SCHOOL OF EDUCATION

OFFICE OF THE DEAN

LONGFELLOW HALL, APPIAN WAY
CAMBRIDGE, MASSACHUSETTS 02138

March 21, 1983

Senator Robert Stafford, Chairman
Subcommittee on Education, Arts and Humanities
United States Senate
Washington, D.C. 20000

Dear Mr. Chairman:

Thank you for the opportunity to present testimony on behalf of the American Educational Research Association regarding legislation to improve mathematics and science education. I am pleased to respond to your questions in your letter of March 10, 1983, regarding the scope of the legislation, potential pitfalls, neglected areas and learning needs. These comments reflect the views of the American Educational Research Association and are specifically directed to the research and development needs in the legislation. I will respond to each of the issues raised by the questions you provided.

Potential Pitfalls and Areas of Neglect

Although the legislation may be focused on mathematics and science education, there is a need to include the complex or higher-order academic skills needed for learning success and mathematics and science. These complex academic skills include reading comprehension and interpretation, creative and analytical thinking, problem-solving and written composition. These skills should be gained in the upper-elementary school years which is where students establish interest and motivation with regard to further work in mathematics and the sciences. We also need to know much more about the educational impact of, and opportunity for, new information and computing technology.

Research and Development

Therefore, it is essential that the legislation include a well-supported section authorizing educational research and development into the following areas: thinking, teaching, and learning in mathematics, sciences, technology (both technical literacy and the uses of technology in education) and the complex academic skills needed to learn these subjects.

Elementary and Secondary Schools - Needed Academic Skills

It is also important that the legislation include all of the aspects of student access and success related to mathematics and science. A major pitfall would be to focus narrowly only on the high school or on the discrete subjects of mathematics and science to the neglect of the academic skills needed to learn those subjects.

Limited Funds - Scope of Funding

Also given the level of authorized funding mentioned in your letter it is important that the legislation (particularly with regard to any formula program for state and local education agencies) be focused or targeted. Such targeting could be done by limiting the scope of the legislation to mathematics, science and the academic skills needed to succeed in those subjects (including the effective use of instructional technology). Similarly you might limit the initial (first two years) of any formula grant program for the schools to high priorities such as re-training or in-service education and efforts to provide a mix of effective teaching strategy through substantive knowledge for teachers. Broader issues and activities could be included in research, development, and dissemination activities or selective demonstrations focused on teacher recruitment, selection and retention activities.

It is also essential that the legislation include a national policy study and evaluation component. We need to determine the extent, location and depth of problems associated with mathematics, science, and technical education as well as the effects and activities stimulated by the legislation. A note of caution regarding any evaluative component is essential. Evaluations which are focused on out-come assessments--particularly student learning--must also be attempted after programs have had the time and resources to be developed, implemented, and established. Although the total amount is limited the national government is the only level with interest in a capacity to invest in knowledge and information generation associated with national issues like mathematics and science education.

Learning Programs

You ask about going beyond teacher improvement and recruitment efforts in this legislation. If the legislation includes or allows (under formula grants) direct support of instructional programs the size of funding would need to be increased--or Congress runs the risk of diluting the impact of federal funds. Programs for gifted students, magnet schools, and efforts to provide increased access and success for special populations or groups traditionally underrepresented in mathematics and science courses should be limited to the R & D projects and limited demonstration efforts.

There is a common practice to accommodate a broad set of interests and needs in legislation. This is an appropriate practice when the act and funding level are designed to support the operation of educational programs. You have indicated that the maximum amount for this legislative package is about $500 million.

If you are to include the needed research and development recruitment incentives, teacher training institutes, and higher education programs, then the state and local programs must be focused (to limited academic areas) and targeted (to limited permissible activities). After the first several of authorized activity and with the increased knowledge and information gained from research and evaluation Congress should then review the legislation and determine if they want to expand the scope and include education operations as a purpose. The needs are great and resources limited. Therefore it is essential that authorized activities have an impact and that resources are not spread so thin as to make no difference.

I have asked David Florio of AERA to provide your staff with the descriptions of a legislative component for an educational research and development section which could be included in the bill. The Association is working with a number of elementary, secondary, and higher educational associations to develop suggestions for the legislation. Those will be shared with you and your staff in the very near future.

If I can be of further service to you or the Committee, please do not hesitate to let me know. The staff of AERA is also available to assist you in any way you deem appropriate.

Sincerely yours,

Patricia Albjerg Graham

Patricia Albjerg Graham
Dean

PAG:gk

**The University
of North Carolina
at Charlotte**

**UNCC Station
Charlotte, N. C.
28223**

**Office of
the Chancellor**

704/597-2201

March 21, 1983

The Honorable Robert T. Stafford
Chairman, Subcommittee on Education,
Arts and Humanities
United States Senate
Committee on Labor and
Human Resources
Washington, D. C. 20510

Dear Senator Stafford:

Thank you for your letter of March 10. I do hope my testimony was useful to the purposes of the Subcommittee, and I appreciate the opportunity to testify. Let me provide you with some ideas in response to the two questions you have posed to me.

I am not able to provide a simple "rule of thumb" that would suggest how available resources might rationally be proportioned between teacher training and instructional equipment for the reason that the crisis in teacher training is immediate and urgent whereas the crisis in instructional equipment is an aspect of the basic structural problem of science in our society. Thus, the allocation of resources between these two important areas is more to be determined by the weight to be given to the immediate as compared with long-range concerns.

In answer to your question about a service requirement in return for publicly supported fellowships and traineeships, I can be somewhat more direct. Generally it is preferable not to attach conditions to grants in support of individual intellectual development. Thus I would advise against attaching a service requirement, except in those instances where a fair return on the public investment almost certainly would otherwise not be realized.

This logic leads me to the following advice:

I assume that federal fellowship and traineeship support for the basic scientific disciplines would be intended to increase and improve the supply of young scientists to populate the science departments of higher education and industrial and governmental laboratories. I do not believe that any service requirement would produce a result less satisfactory than that which will occur through free decision and thus could not recommend it.

On the other hand, it seems to me very likely that a fellowship and traineeship program designed to produce an increased number of high quality teachers for the elementary and secondary schools would produce many graduates who would be attracted directly from college to industrial and governmental positions without giving their intended professions a chance. In this case, an appropriate service requirement would both give some return on the public investment and give to the graduate appropriate experience from which he or she could make a well informed life-time decision.

I hope these responses are useful to you and the Subcommittee on Education, Arts and Humanities.

Sincerely,

E. K. Fretwell Jr.
Chancellor

EKF/nr

The University
of North Carolina
at Charlotte

UNCC Station
Charlotte, N.C.
28223

Office of
the Chancellor

704/597-2201

April 13, 1983

The Honorable Christopher J. Dodd
United States Senate
Committee on Labor and Human Resources
Washington, D. C. 20510

Re: Response to Questions by the Subcommittee on Education, Arts and Humanities

Dear Senator Dodd:

By letter of March 30, 1983 (attached), Senator Stafford, in his capacity as Chairman of the Subcommittee on Education, Arts and Humanities, asked me to respond to certain questions posed by you and Senator Pell, following up my earlier testimony before that committee.

To answer those questions, I solicited information and insight from Dr. Floyd Mattheis, Chairman, Department of Science Education, East Carolina University; Mr. Tom Rudin, Governor's Task Force on Science and Technology, Office of the Governor, State of North Carolina; Dr. Paul Taylor, Director, Division of Science, North Carolina State Department of Public Instruction; and Dr. Bob Williams, Associate Dean of Education, North Carolina State University. These individuals were in a position to respond very directly to the questions posed. The attached statement is a summary of the responses of those resource persons.

I hope my response is of some assistance. If you require additional information or clarification, please contact me.

Sincerely,

E. K. Fretwell Jr

E. K. Fretwell Jr.
Chancellor

ss

Attachments

cc: ✓Mr. David Morse
Subcommittee on Education, Arts and Humanities
Committee on Labor and Human Resources
United States Senate
Washington, D. C. 20510

Response to Questions by
the Subcommittee on Education, Arts and Humanities
March 9, 1983 Testimony
E. K. Fretwell Jr.

QUESTION 1: With respect to the math and science needs, are there some school districts that need more help than others?

Should we target aid on the basis of need, and if so, could you suggest criteria?

RESPONSE: Sources agree that some school districts may need more help than others and indicate that need should be one criterion for the targeting of aid. Allocation perhaps should be based on a per pupil expenditure, student population, or the use of school/population percentage below poverty level.

Suggestion: Formula for rewarding school districts who are trying -- perhaps 50/50 matching funds to stimulate local school districts.

Distinction needs to be made in regard to areas of shortage in science -- (e.g., Biology--fewer shortages occur). Funding should target shortage areas such as chemistry, physics, earth sciences.

QUESTION 2: There is much talk about unqualified teachers teaching math and science. To what extent do you feel this is a true and accurate assertion? Also, to what extent is it due to teachers in other areas teaching math and science in order to keep their jobs in the face of education cutbacks?

RESPONSE: Enclosed are 1981-82 data illustrating the extent to which non-certified teachers are teaching science and mathematics in North Carolina. To summarize, only 41 percent of teachers who taught junior high mathematics were appropriately certified. Sixty-eight percent of the teachers who taught non-college preparatory high school mathematics courses were appropriately certified, and 97 percent of those who taught college-preparatory mathematics were appropriately certified.

It appears that a great deal of the certification problem is due to other (non-certified) teachers, perhaps with tenure, teaching sciences and mathematics. Problems appear to be created by the shortage of qualified mathematics and science teachers and by various administrative practices in certain schools and school districts.

Questions arise in regard to certification and qualification. For example, properly certified science teachers may hold certification to teach any science course. Investigation, however, reveals teachers specialized in one area of science (ex: Biology) may be certified in all areas--Chemistry, Physics, Earth Science, Biology--but are teaching in an out-of-specialization area (Chemistry), thus revealing a "biologist in chemist's clothing." Therefore, teachers may be certified but not qualified.

Another study cites that a substantial number of teachers are teaching out-of-field due to factors such as

-- that was the only area available for teaching

-- the desire to work

-- the principal assigned the teaching field

The comments are valid in North Carolina because, at present, there is no state law that forbids out-of-field teaching.

QUESTION 3: In this period of economic difficulty and budget cutbacks, some teachers have lost their jobs because schools have faced severe funding reductions. Do you have any idea of the math and science teachers we have lost through this situation? Also, to what extent have teachers in other areas transferred to the teaching of math and science in order to remain employed?

RESPONSE: Specific data is not available. Research in this area is just beginning. Sources indicate a heavy attrition rate in the teaching fields of mathematics and science, twice the rate of all other fields, occurring during the first few years in the field. Factors contributing to attrition may be due to reduction in force while much may result from career changes and retention of teachers with seniority in fields other than science and mathematics.

QUESTION 4: Are there considerations other than pay that have the effect of driving math and science teachers away from the teaching profession?

RESPONSE: The answer to this question is clearly "yes." Sources cite significant factors in science teacher attrition. These include: pay; availability of facilities, equipment and materials to conduct laboratories; availability of time for adequate instruction; amount of non-instructional duties; class size; opportunity for professional growth; local school support; and, job stress.

Additional survey information identifies incentives for retaining mathematics and science teachers through:

(1) Providing a better climate for teaching in the classroom and throughout the school through

   a. reduced class size

   b. providing opportunities for teachers to update themselves

   c. reduction in number of classroom disruptions by students

   d. recognition for good job when done

   e. protection from parents who unjustifiably challenge teachers' control and judgment.

(2) Assuring that mathematics/science teachers are allotted sufficient equipment and materials to be funded annually.

(3) Providing scholarships for teachers to return to college and upgrade teaching skills.

QUESTION 5: Is there a real danger of disparity among schools with respect to computer access and, if there is, should we make computer access a federal responsibility rather than a state and local one?

RESPONSE: A disparity appears to exist that could worsen as we progress further into the "computer era." Sources indicate that the burden for alleviating disparities should rest with state and local governments. The overriding concern is that the haphazard use of federal funds may not provide the state and localities with incentives to develop a strong education program. Suggestions include distribution of federal funds to state education authorities which can then pass funds to local districts, and the provision of a matching funds system that could stimulate interest and support locals to take the initiative.

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United States Senate

COMMITTEE ON LABOR AND
HUMAN RESOURCES
WASHINGTON, D.C. 20510

March 30, 1983

Dr. EK Fretwell
Chancellor
University of North Carolina-Charlotte
UNCC Station
Charlotte, N.C. 28223

Dear Dr. Fretwell:

Senators Pell and Dodd have asked me if I would transmit to you, for written response, questions regarding your testimony at the Subcommittee's hearings on mathematics and science education.

I would very much appreciate it if you would respond directly to them, with a copy of your answers directed to David Morse of my Subcommittee staff. As the Subcommittee will be meeting to consider legislation early in April, it is important that your responses be returned by April 8.

Thank you for your attention to this matter.

Sincerely,

Robert T. Stafford

Robert T. Stafford
Chairman
Subcommittee on Education,
Arts and Humanities

RTS:DMt
Enclosure

RECEIVED
APR [illegible] 1983
CHANCELLOR'S OFFICE

SENATOR PELL

QUESTIONS FOR WITNESSES FOR THE MARCH 9th HEARING ON S. 530, THE EDUCATION FOR ECONOMIC SECURITY ACT, AND RELATED LEGISLATION

QUESTIONS FOR PANEL II

1. With respect to the math and science needs, are there some school districts that need more help than others?

   Should we target aid on a basis of need, and if so, could you suggest criteria?

2. There is much talk about unqualified teachers teaching math and science. To what extent do you feel this is true and accurate assertion? Also, to what extent is it due to teachers in other areas teaching math and science in order to keep their jobs in the face of education cutbacks?

3. In this period of economic difficulty and budget cutbacks, some teachers have lost their jobs because schools have faced severe funding reductions. Do you have any idea of the math and science teachers we have lost through this situation? Also, to what extent have teachers in other areas transferred to the teaching of math and science in order to remain employed?

4. Are there considerations other than pay that have the effect of driving math and science teachers away from the teaching profession?

5. Is there a real danger of disparity among schools with respect to computer access, and if there is, should we make computer access a federal responsibility rather than a state and local one?

INDIANA UNIVERSITY
OFFICE OF THE DEAN

SCHOOL OF EDUCATION
W.W. Wright Education Building
3rd and Jordan
Bloomington, Indiana 47405

March 30, 1983

The Honorable Robert T. Stafford
Chairman
Subcommittee on Education, Arts
and Humanities
United States Senate
Washington, D. C. 20510

Dear Chairman Stafford:

I wish to respond to the two questions contained in your March 10 letter. Your letter arrived while I was away, leading to a delay in my response. I hope these brief answers are still useful, given your schedule.

---

1. Is there any "rule of thumb" we should follow in determining the proportions of funds to be expended on teacher training, for example relative to instructional equipment or instrumentation?

As you may suspect, there is no clear-cut answer to your question. Experts will differ on what is best to do. However, here are some suggestions to guide your thinking.

-- Much attention has been given to the shortages of math and science teachers and the necessity to lure new people into these fields. This problem demands attention, and various solutions to the problems of teacher recruitment and retention have been offered. But we cannot overlook the fact that most instruction will continue to be provided by math and science teachers who are currently employed and likely to be retained. Some of these people had only marginal preparation in the past; in a majority of cases, their prior training is becoming out-of-date. Therefore, some kind of in-service education for existing math and science teachers is important.

-- The continuing education problem is more extreme for elementary school teachers, many of whom had very little math and science as part of their undergraduate education. Since student attitudes toward and knowledge of math and science are greatly affected by the kind of instruction provided in the elementary grades, it is especially important to provide carefully tailored in-service instruction for elementary school teachers in order to convince them to devote greater attention to math and science.

-- The in-service and pre-service education of teachers will continue to be an important problem for many years. No quick solution is possible. We should see this as a continuing task. But the problem of equipment and facilities seems different to me. Many teacher education departments lack proper equipment and facilities to prepare teachers. Their science education labs are antiques; they lack microcomputers to teach teachers about their use. It is possible to make rapid advances in this arena and observe a rather quick turnaround. I would recommend especially an investment approach that calls for a partnership among the Federal government, business, and higher education institutions.

2. How much scientific background does a school teacher at the elementary level need to adequately teach math and science?

In order to become adequately prepared to teach elementary school science, a teacher needs approximately 15 to 16 semester hours of university, undergraduate-level science courses, fairly evenly distributed among astronomy, biology, chemistry, geology and physics, as well as sufficient credit hours of pre-calculus mathematics to be at ease using mathematics and computers in an elementary science program.

Since introductory, university-level science courses frequently are designed to prepare students for second-level science courses, rather than for teaching in the elementary school, it is necessary to pay attention to the nature of such courses and not be overly impressed by the total number of credit hours earned. A well-prepared teacher should be able to apply knowledge acquired in college-level science courses to instruction at the elementary school level, including the design of appropriate laboratory lessons, should acquire an understanding of science processes and the content of elementary school science curricula, and should comprehend and be able to question the science reported by the popular media and articles appearing in publications such as Science '83, Omni or Discoverer. Along with good teacher preparation, teachers require adequate support for materials and equipment and sufficient time to plan for instruction and to remain abreast of developments in science and science education. Both good working conditions and highly qualified teachers are needed to provide optimum science and math instruction.

Please call or write if I can be helpful in other ways.

Sincerely yours,

Howard Mehlinger

Howard Mehlinger
Dean

THE
CATHOLIC UNIVERSITY
OF AMERICA
WASHINGTON D.C. 20064

OFFICE OF THE PRESIDENT
202 635-5100

March 17, 1983

Mr. David J. Morse
Subcommittee on Education,
Arts and Humanities
United States Senate
428 Dirksen Senate Office Building
Washington, D. C. 20510

Dear Mr. Morse:

I submit the attached in answer to Senator Stafford's request for a response to a question related to my testimony before the Subcommittee on Education, Arts and Humanities.

Yours sincerely,

William J. Byron, S.J.
President

1. Is there any "rule of thumb" we should follow in determining the proportions of funds to be expended on teacher training, for example, relative to instructional equipment or instrumentation?

I think there should be a balance between "persons" and "property" as the funds are distributed. This does not, however, mean an even split, particularly since other legislation will address itself to the renovation of facilities and the tax laws are providing improved incentives for gifts of scientific equipment to academic institutions from private industry.

I would therefore suggest the following distribution: 50 percent for renewal, retention and retraining of teachers; 20 percent for scholarship assistance to college students interested in becoming teachers; 20 percent for research on the problems of student motivation, effective methodology, and curriculum development in the areas of mathematics, science and foreign languages; and 10 percent for scientific equipment.

William J. Byron, S.J.
President
The Catholic University of America

3/18/83

THE
CATHOLIC UNIVERSITY
OF AMERICA
WASHINGTON D.C. 20064

OFFICE OF THE PRESIDENT
202 635-5100

RECEIVED
APR 11 1983

April 8, 1983

Memorandum

To: Senators Claiborne Pell and Christopher Dodd

Re: Responses to Your Questions on
Math and Science Education

Your questions were forwarded to me by Senator Stafford. I hope these replies will be helpful.

William J. Byron, S.J
President

cc: David Morse,
Subcommittee Staff

QUESTIONS FOR WITNESSES FOR THE MARCH 9 HEARING ON S. 530, THE EDUCATION FOR ECONOMIC SECURITY ACT, AND RELATED LEGISLATION

QUESTIONS FOR PANEL II

1. With respect to the math and science needs, are there some school districts that need more help than others?

   Should we target aid on a basis of need, and if so, could you suggest criteria?

   I would want to define need in terms of potential--i.e., the potential that needs to be developed. Federal aid should be targeted on potential for excellence, both in teachers and students.

   The identification of such potential in students would be assisted by standardized tests in high school and appropriate aptitude tests in early grades to identify children who possess potential for quantitative work. Once the potential is established, they would be given the opportunity to enter special classes, use special equipment, etc.

   In teachers the potential for excellence can be measured by past academic training, evaluation of past teaching and aptitude or preference tests. Again, it is the potential for quantitative and scientific reasoning that should be the basis for targeted aid focused on faculty development.

2. There is much talk about unqualified teachers teaching math and science. To what extent do you feel this is true and accurate assertion? Also, to what extent is it due to teachers in other areas teaching math and science in order to keep their jobs in the face of education cutbacks?

   I have no way of measuring the extent of this problem, but it does exist--i.e., there are incompetent teachers of math and science now at work in the classrooms. Some are people trained in other fields, but some are also persons of no quantitative potential who are poorly trained to teach math and science.

3. In this period of economic difficulty and budget cutbacks, some teachers have lost their jobs because schools have faced severe funding reductions. Do you have any idea of the math and science teachers we have lost through this situation? Also, to what extent have teachers in other areas transferred to the teaching of math and science in order to remain employed?

   I have no way of measuring either of these developments. I feel the much more critical problem is the loss to industry of good math and science teachers who are inadequately compensated in the schools.

4. Are there considerations other than pay that have the effect of driving math and science teachers away from the teaching profession?

   Yes. Other considerations would include discipline problems in the classroom, lack of parental interest and cooperation, inadequate equipment and deteriorating school facilities. Moreover, society at large, gives insufficient recognition and status to the teaching profession. Finally, the business community has made no real effort to provide meaningful, systematic summer employment to teachers.

5. Is there a real danger of disparity among schools with respect to computer access, and if there is, should we make computer access a federal responsibility rather than a state and local one?

   There is a real danger, but I tend to favor a targeting of federal aid on persons (who migrate freely across state lines) while encouraging more state and local aid on equipment and facilities (which almost always remain in place).

William J. Byron, S.J.
President
The Catholic University of America

April 8, 1983

MLA

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18 March 1983

Senator Robert T. Stafford, Chairman
Subcommittee on Education, Arts, and Humanities
SD-428 Dirksen Office Building
United States Senate
Washington, DC 20510

Attn: Mr. David Morse

Dear Senator Stafford:

Thank you for affording me an opportunity to respond to specific questions relating to my testimony of March 9 and to the general concerns of foreign language education. My response, on behalf of the coalition of professional organizations I represent, is as follows:

Question 1. Do you think that an increased commitment to existing programs such as Title VI should take precedence to any new program to increase the federal commitment to improving foreign language education?

Response: Our profession continues to support the objectives and programs of Title VI, HEA which we believe are central to the interests of the nation in foreign policy, foreign trade, and international relations. We believe Title VI should be maintained at least at present levels and hope that Congress will find it possible to increase funding for these essential programs.

New programs to improve foreign language education, we feel, should not be undertaken at the expense of those with a proven record of accomplishment. Most of the programs that have been proposed have objectives complementary to those of Title VI. By focusing primarily on secondary school and undergraduate instruction, they would impact on a wide segment of the population while at the same time providing the necessary base for the training of future specialists. The principal concern of new programs, we believe, should be the development of a pool of skilled and proficient teachers able to meet the increased demand anticipated in both schools and colleges in consequence of the reinstatement of language requirements at a growing number of institutions and the establishment of diploma requirements in many secondary school districts, including cities like New York and Baltimore.

With evidence of an emerging teacher shortage already at hand, our profession anticipates serious shortages by the mid-1980s. In recent years, many university-based teacher training programs have been dismantled or diminished as a result of a decline in job opportunities and the growing unattractiveness of teaching as a career. As the pendulum begins to swing back, many of these institutions will lack the staff necessary to provide training for new cohorts of teachers. Funds will be needed to help these institutions cover start-up costs, provide incentive fellowships for new teachers, and help both new and experienced teachers acquire the skills needed to meet new demands on their expertise: for example, to administer oral interview tests, develop career-oriented curricula, and make effective use of new audiovisual and computer technologies.

(continued)

Question 2. Where should the emphasis on foreign language education be placed--on secondary education or on colleges and universities?

Response: With four times the language enrollments of the colleges and universities, the secondary schools, we believe, should be the principal arena for action and change in language education. A major focus of federal attention should be pre-service and in-service training for secondary school teachers, but support is also needed for the development and dissemination of model curricula, the establishment of internationally oriented magnet schools, and instruction, at selected high schools, in the less commonly taught languages. At the same time, colleges and universities will continue to provide the bulk of instruction in the less commonly taught or "critical" languages, advanced training and research in language and area studies, and graduate training for professionals in all languages at all levels. The universities are also the focus for research and experimentation in linguistics and pedagogy, and they provide leadership for reform and professional development, such as the current effort within our profession to achieve consensus on proficiency goals and proficiency-oriented curricula. Current efforts to encourage productive interaction and collaboration between school and college faculty need to be expanded and developed.

Question 3. Is there any "rule of thumb" we should follow in determining the proportions of funds to be expended on teacher training, for example, relative to instructional equipment or instrumentation?

Response: In our view, support efforts in the area of foreign language education should be concerned primarily with teacher training and curricular development and dissemination, not with equipment. As a "rule of thumb" we would propose that not more than ten percent of funds be allocated to equipment. In the case of video playback equipment, for example, most educational institutions are already reasonably well furnished with serviceable machines; what teachers need now is ongoing information and advice on available films and cassettes, and guidance in their use as instructional media. In the case of computers, institutions are acquiring hardware for a variety of purposes with funds from a variety of sources. Since courseware must be tailored to the specific hardware in place, the essential element in the process of selecting, developing, and implementing courseware for language instruction will be teacher expertise. Accordingly, the focus of any support effort should be on making computer literacy and courseware development part of the professional training of teachers.

Thank you again for inviting us to offer testimony to the Subcommittee on these issues.

Yours sincerely,

Richard Brod

Richard I. Brod, Director
Foreign Language Programs, MLA
Secretary-Treasurer, JNCL

BMCC
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March 17, 1983

Senator Robert T. Stafford
Chairman
Subcommittee on Education, Arts and Humanities
U.S. Senate
Committee on Labor and Human Resources
Washington, D.C. 20510

Dear Senator Stafford:

In response to the question posed by your letter of March 10th, I offer the following observations:

The needs will vary from campus to campus and district to district. Of course, while instructional equipment is an increasingly critical element showing a growing number of courses cutting across science, mathematics, communications, management and office services, the health sciences and other technical courses, the hardware cannot compensate for deficiencies in course content or faculty skill. We are a rather hard-ware happy country, and perhaps too often we allow our hardware to give us a false sense of security about the quality of what we are doing.

While we do not support inflexible allocations, we think the House has acted wisely in Title II of HR 1310, at least in the community college program therein, in specifying that not more than 50% of the grant to any institution or program can be spent on any single need among the several needs enumerated in the bill for the development of high technology programs.

We thank you again for the opportunity to share your views.

Sincerely yours,

Joshua L. Smith
President
and
Vice Chairman AACJC/ACCT
Joint Commission on Federal Relations

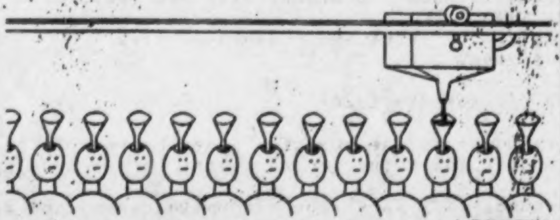
cc: Rep. Don Faqua
Rep. Doug Walgren
Judith Madonia
Frank Mensel
Dale Parnell
William Meardy

WASH. POST 1/30/83

INSI

High-Tech Requires Few Brains

The jobs being created will demand less skill, not more



By [illegible]

By Henry M. Levin
and Russell W. Rumberger

MUCH IS BEING MADE of our arrival into the age of high-technology. In Massachusetts last week, President Reagan declared the country is "in a great transition" to high tech, furthing the notion that the nation's economic ills will be cured by our new sweetheart industry as it spawns massive numbers of new jobs requiring sophisticated mathematical and engineering training while reducing or even eliminating opportunities for the unskilled.

Well, the evidence suggests it isn't going to work that way.

High tech is neither the place where most new jobs will be found nor will high tech require a vast upgrading of the skills of the American labor force. To the contrary, the expansion of the lowest-skill jobs in the American economy will vastly outstrip the growth of high-technology ones. And the proliferation of high-technology industries and their products is far more likely to reduce the skill requirements for jobs in the U.S. economy than to upgrade them.

Last year the Labor Department did project that in the '80s, jobs for computer programmers would grow between 74 and 148 percent while overall job growth would only be 22 percent.

But the percentages are misleading. The total number of new jobs for computer programmers is expected to be 150,000. Some 1.3 million new jobs are projected for janitors, nurses' aides and orderlies. That's nine unskilled jobs in these categories alone for every computer programmer. In fact, no high-tech job even makes the Labor Department's top 20 in terms of total numbers of jobs added to the U.S. economy.

New jobs for data-processing-machine mechanics will increase 148 percent, the fastest growing job category. But that large gain translates into an increase of less than 100,000 new jobs, while 800,000 new jobs are projected for fast-food workers and kitchen helpers alone.

Of course, occasional shortages of skilled workers will arise in particular occupations and industries as they have occurred historically. Both the economy and educational system will have to make specific adjustments to alleviate them. But that is hardly the general shortage of skilled workers projected by those who have exaggerated the effects of high-tech.

Neither will the high-tech transformation of existing jobs create demands for increasingly sophisticated work skills. Secretaries will work with word processing equipment; bookkeepers will use computerized, financial spread sheets; purchasing and inventory clerks will apply computerized record systems; mechanics will use diagnostic equipment employing minicomputers; telephone operators will rely on computerized directories.

But there is little evidence that these jobs will require workers with more sophisticated skills. To the contrary, studies suggest that the new technologies provide opportunities to further simplify and routinize work tasks and to reduce the opportunities for worker individuality and judgement.

In such diverse areas as office work, data processing, drafting, wholesale and retail trade, and computer programming, microcomputers are making it possible to utilize persons with lower skills to perform highly sophisticated functions.

Using computers does not necessarily require computer skills. For example, the new generation of office computers is specifically designed so that "no special computer skills are needed." The latest word processors can even correct typing errors automatically by the use of electronic dictionaries, so letter-perfect typing and strong spelling skills are no longer required.

As computer languages have become more "user-friendly" and sophisticated software has become available for a large variety of tasks, [illegible] computer [illegible] tions have been eliminated or downgraded in terms of their skill requirements.

In fact, the use of sophisticated equipment often means that the worker requires less sophisticated skills. Today's Ford Escort is far more sophisticated than the Model "T" of 50 years ago. Yet it is far easier to drive today's vehicle. Computers are far more sopisticated today than they were 10 or 20 years ago. Yet the average programming task is considerably less demanding than it was when there was the need to reprogram plugboards and work in machine languages.

Workers will need to learn different skills rather than more demanding ones. Certainly word processing is different in some respects from typing. However the new skills needed can be acquired through on-the-job training. An expanded foundation in science, mathematics, and computer programming is hardly necessary.

We see an entirely different set of problems arising from high tech than is popularly assumed. Not only will the economy create more low-skill jobs than high, it is possible that high tech will eliminate far more jobs than it will create. For example, experts suggest that the use of computer-assisted design (CAD) software may eliminate a majority of the 300,000 drafters in the U.S.

If the future of work is being written in Silicon Valley, the danger signs are already evident. Although there are clearly some high-level executives, programmers, and engineers who are stimulated by their jobs in the Valley, most workers in these industries are clerical employes, assembly workers, and low-level technicians the challenges of whose labor may leave something to desired.

A recent front-page story in The San Jose Mercury estimated that a third of all workers in the Valley are involved in drugs and alcohol and that drugs are largely responsible for thefts on the job, [illegible]

It is time that we [illegible] look at the job implications of high technology, rather than blindly accepting the folk wisdom on the subject.

Henry M. Levin is director of [illegible] and Russell Rumberger is a research economist at the Institute for Research on Educational Finance and Governance at Stanford University.

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24 March 1983

Senator Robert T. Stafford
Chairman
Subcommittee on Education,
Arts and Humanities
SD-428 Dirksen Senate Office Building
Washington, D.C. 20510

ATTN: Mr. David Morse

Dear Senator Stafford:

Thank you for your kind letter of March 10, 1983. It was entirely my pleasure to appear before your subcommittee. My response to the questions posed in your letter are as follows:

In regard to Mr. Henry M. Levin's article in the January 30, 1983 issue of The Washington Post. As you noted, part of Mr. Levin's article suggests that many new jobs within the data processing industry will not require an "extensive" background in math and science. Mr. Levin is correct. There are indeed many data processing support and spin-off jobs where "extensive" math and science is not a mandatory requirement. Within my own company, I would estimate that each "high tech" position generates approximately four other less technical positions. While these less technical positions do not require the depth of math and science knowledge you would expect of an engineer or a scientist, they do require a sound basis in those disciplines.

If we use Mr. Levin's data and logic, it is possible to argue that each new computer programmer position will generate the need for nine other unskilled (non technical) jobs, i.e., janitors, fast-food workers, etc. The economic result then is that one high tech position creates four other less technical jobs which, in turn, generate 36 unskilled jobs. In my opinion, that's a pretty good argument for your Bill.

I think that the principal item in Mr. Levin's article that distrubs me is the inference that unskilled labor should be relegated to their fate. Mr. Levin is apparently unconcerned with providing the educational opportunity which would permit them to improve their situation. Having personally worked my way through 17 years of night school to earn a Bachelors and a Masters Degree, I am comforted that Mr. Levin had no control over my destiny.

I would not suggest that everyone be trained as a mathematician, scientist, or an engineer, but as those professions advance and influence our daily lives through technology, there is a proportional need for a sound basis in the tools of technology at all other levels, i.e., science and mathematics.

Today's high technology is tomorrow's norm and education must keep pace with technological growth or our society and economy will certainly become stagnant. I have attached an article by Louis A. Girifalco from the Fall 1982 issue of The Wharton Magazine entitled "The Dynamics of Technological Change" which addresses this issue in greater detail.

Your second question related to Legislative encouragement to create a mutually beneficial relationship between education and industry. I believe this could occur in several forms ranging from Government sponsored programs to informal contacts between Legislators, educational institutions, state bodies, individual industries, and affiliated associations. Some possible examples of such encouragement might be:

a) Encourage industry to seek accreditation of its suitable training programs, at both the high school and college level.

b) Recognize that the cost of training in industry is, in some cases, related to the social goals of educational institutions and perhaps should receive some tax credit for its cost.

c) Recent industry retirees should be encouraged to enter education -- not to supplant the teacher's role, but to enhance it. A program to permit these retirees to participate in their field of expertise, without having to become certified teachers, could bring pragmatism to the classroom in all fields of study and relieve overworked teachers at minimal costs. This suggestion is similar to existing Junior ROTC programs where military retirees teach and administer the ROTC programs at minimal costs to the High Schools involved.

d) Consideration might be given to a non-attributed scholarship program sponsored by the Government but funded by donations from industry who would receive an equitable tax write-off based on their contributions. Administration of this program would be by a committee made up of representatives from education and industry. This committee would award scholarship funds to those institutions that either maintain, or are attempting to establish, strong curriculums to support current technology.

e) Where appropriate, exchange programs between industry and education should be encouraged. Primarily this encouragement should be in the form of personal influence on the part of Legislators. Tax benefits and grants-in-aid may also be appropriate in some instances, especially where the exchange program supports Federally sponsored research and development or contractual obligations.

f) Finally, I would not overlook the impact of personal appeals on the part of Legislators to industry and education to form informal, cooperative partnerships at the local level.

I want to thank you and your subcommittee for the opportunity to offer my testimony and respond to your questions. I am pleased to be of any assistance in your endeavors to improve the quality of education.

Sincerely,

Gilbert D. Johnson

Gilbert D. Johnson
Manager
Training and Education

The Dynamics Of Technological Change

Technological change is frequently discontinuous. The major challenge we face as a technological society is to learn how to navigate these discontinuities.

By Louis A. Girifalco

TECHNOLOGY is as old as the human race. The bow, the first flint knife, and even the stick are technological devices developed by man over the millennia to extend human capabilities. But within the last century or two – a very short time on a historical scale, the barest instant by evolution's clock – something new has appeared. Since the coming of industrialization, not only the rate but the very nature of technological advance has changed.

Pre-industrial technology was little more than technique. Lacking any extensive scientific base, its growth was slow and incremental, and it depended on muscle – human or animal – for motive power. Modern technology, on the other hand, is characterized by rapid and often dramatic growth. It has its roots in widespread and vigorous scientific research, and it uses extraordinarily powerful energy sources.

Above all, modern technology represents a new way of seeing the world. For us, nature is something to be known and controlled, time and space things to be explored and conquered. Humanity is no longer a slave of fate or a servant of unknown, mysterious forces, but a master, able to exercise power for its own ends.

A central fact of modern technology is this: It came upon us suddenly and without warning. We were unprepared for it, and we must quickly learn a new mode of living. It is no wonder that we see so much concern and suspicion about new technological developments, and that doomsaying is a growth industry. Yesterday we were grubbing for roots and hunting with clubs; today we travel in jet planes, are surrounded by computers, and have the power either to destroy our world in a matter of minutes or to create a new one of great glory. We are crossing a discontinuity and are not sure that we can handle it.

It is clearly vital that we understand as much about technological change as possible, not only for its intrinsic interest, but because the extent to which it can be properly controlled and guided depends on our knowledge of its nature and its dynamics – the rates of technological change and the forces that impel those changes.

At present, our knowledge of technological dynamics is quite rudimentary. We do not even have a clearly defined methodology for coming to grips with the subject. Nevertheless, a certain amount of information is available, and work has been done that is highly suggestive. We are able to make some statements which, while they do not quite deserve to be called conclusions, yet are more than just speculations:

☐ The flow of technology is not continuous. Far from being a steadily expanding stream, technological growth is a series of bursting tides with each crest higher than the last. This seems to hold at every level, from specific research and development projects to the worldwide technological enterprise as a whole.

☐ The pace of technological change is – as so many of us feel in our bones – getting faster. Both the number of innovations and their rates of development are increasing.

☐ The time scales of technological progress do not match the time scales of our decision-making processes, with disastrous results for our ability to design rational policies.

☐ As a particular technology is exploited, the time comes when either its potential is exhausted or it is superseded by a better technology. Too often, the transition occurs in a discontinuous manner with poor preparation and severe dislocations.

The traditional picture of the flow of technology starts with a discovery made by someone pursuing science for its own sake, which is then taken up by engineers, entrepreneurs, and businessmen to create a new product or service that can be sold. This goes on at an ever-increasing rate, giving us exponential technical growth. Although the reality is much more complex, this picture suggests a number of questions that are important for the dynamics of technological change.

These questions are of two kinds. The first are of a descriptive nature and ask

Louis A. Girifalco is University Professor of Materials Science at the University of Pennsylvania. This article is based on a lecture he delivered for the Herbert Spencer lecture series at the University of Pennsylvania.

what is going on and how fast it is happening. For example: What is the time lag between scientific discoveries and their commercial application? What is the frequency of new technological developments, and how does their frequency change over time? What is the rate at which new technological developments spread, and how long does it take for a new technology to supersede an older one?

The second kind of question is more profound and concerns the reasons the changes are taking place and the factors controlling their rates of development. Questions at this second, explanatory level would include: What determines the time lags between scientific discovery, invention, and commercial application? What are the forces that inhibit or encourage technological change? What determines the rate of technological innovations and the rate at which they spread?

We can say more at the descriptive level than at the explanatory one – where the really critical issues lie. But even at the descriptive level there are serious problems of carefully defining terms, of choosing measures for rates of growth, and of finding or selecting appropriate data. In other words, the conceptual groundwork even for the description of technological dynamics is still uncertain. And the second, explanatory, level is much harder to handle, including a host of technological, economic, regulatory, and social factors that are intertwined in complex and varying ways.

Still, some progress can be made by examining the available descriptive information on technological change, and trying to generalize it in the hope that we will then be led to some insight about the basic controlling forces.

There are four kinds of data useful to us in this endeavor: 1) the rate of *technological diffusion* (the spread of a new technology through a given industry), 2) the rate of *technological substitution* (the replacement of one technology or product by another), 3) the frequency of *technological innovation* (the number of new developments introduced per year), and 4) the *innovation time lag* (the time between an invention and its commercialization).

The work of gathering and analyzing this data can seem prosaic and even dull. After all, there is nothing intrinsically exciting about the number of steel companies that adopt the basic oxygen furnace, or the number of television sets purchased, unless you happen to be in the business of selling oxygen furnaces or television sets. However, analysis of the empirical data can lead to far-reaching conclusions with the most profound implications not only for the world's present condition but also for its future.

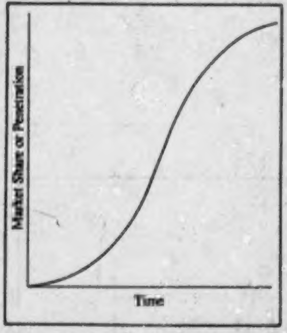
A Look at the Data

The seminal work on technology diffusion was done by Edwin Mansfield, a pioneer in the quantitative analysis of technological change. For each of four industries (bituminous coal, iron and steel, brewing, and railroads) he examined the time it took for a new technological development to spread from company to company within its industry. His results indicated that after a new technology was adopted by one or two companies, it spread to other companies at an initially slow rate. This rate increased rapidly for a time, then slowed once more, leveling off as all the companies that would adopt the new technology did so.

Studies of this type have been done for a number of new technologies, ranging from catalytic cracking to numerically controlled machine cutting, and also for the international diffusion of technology as a whole. The results are all similar. When the number of firms that have adopted a new technology is plotted as a function of time, we get the S-shaped curve that is shown in Figure 1.

Before considering the meaning of this, let us look at the somewhat different but related phenomenon of substitution: the displacement in the marketplace of one product by another of superior technology. Examples would include the substitution of transistors for radio tubes, of jet engines for piston engines in aircraft, and of synthetic fibers for natural ones.

Figure 1.



A great many such cases have been studied, and when the market share of the new product is plotted against time, again the S-shaped curve is the result.

For technology diffusion or substitution, then, the merit of the new technology becomes apparent as its use is more widespread, and the technology grows until all available customers are used up. Two features of this pattern have wide applicability.

First, the growth curves are nonlinear. A new technology does not grow in a simple, progressive way. Technological change not only has a velocity, it also has an acceleration. We are accustomed to thinking that tomorrow will be pretty much like today, and that any changes between today and tomorrow will be pretty much like the changes between yesterday and today. This is simply not true for technological change.

Second, there is a limit to how much a technology can spread. It is obvious that when a technology has saturated its market, it cannot grow any further. This is a simple fact. However, many people in leadership and policy-making positions forget this, and act as if there are no such limits.

How quickly does a new technology supersede an older one? The takeover time –how long before a new technology moves from a 10 to a 90 percent share of the market – can vary greatly. For instance, the takeover time for computer calculators was only eight years, while it took nearly sixty for synthetic rubber to replace natural rubber. For a large number of technological changes, the takeover time has ranged between twenty and fifty years. Averaging over household appliances of various kinds, for example, a takeover time of 27 years was found.

While the S-curve gives a good general picture of how a technology grows, the specific values of the takeover time are determined by the forces behind the technology. These are not clearly understood, although some work has been done on the effects of such factors as the return on investment, the cost of introducing a new technology, and general economic conditions.

It is important to remember that when a new technology wins, an old one loses. The S-curve is the result of new technology growing at the expense of old – and indeed, often at the expense of com-

Technological Discontinuity and the Kondratieff Cycle

TECHNOLOGICAL discontinuities occur not only as a result of competition, but also because a technology becomes mature. By 1975, for example, more than 95 percent of all electrically wired households in the United States had radios, refrigerators, vacuum cleaners, washers, dryers, and television sets. The entire appliance industry, which had been geared for growth for several decades, has now only a stagnant replacement market.

A mature industry is a troubled industry. The demand for its products levels off and falls, and unless it can cross the discontinuity to a new line of products, it stagnates. This is, in fact, the kind of explanation advanced for the existence of the waves of innovation documented by Gerhard Mensch, and their relation to the long waves of economic activity with periods of prosperity and depression postulated by Nikolai Kondratieff. In the 1920's, Kondratieff, a Russian, studied the long range price movements of commodities in France, Britain, and the United States, on which he based his theory of long waves. (Marxist philosophy had no place for a theory that described capitalism as periodically revitalizing itself, and Kondratieff ended up in a Siberian prison camp.)

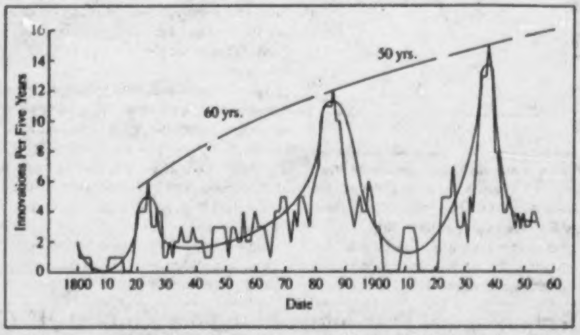
As a new cluster of technologies is exploited, it attracts capital and labor; investment and employment are high, and the economy booms. Just as the technologies mature, the markets stop growing, return on investment goes down, demand for labor decreases, and the economy goes into a slump until the next wave of technologies comes along.

In this theory, the Kondratieff cycle is driven by the cycle of technological innovation, a view in accordance with the observation that economic and innovation cycles have the same frequency but are out of phase. Furthermore, the time between two cycles (about 50 years) is just about equal to the average time it takes for individual technologies to start, grow, and go to stagnation as they climb their S-curves. But the transition from one cluster of technologies to another, from one cycle to the next, is discontinuous since there is no preparation for the new wave until the old one is spent.

Radical innovations take place during periods of depression. During prosperous times, there seems to be no reason to go into anything new. Investment in the current technologies pays well, without the risks attending untried ventures. During depressions, however, capital seeks new kinds of investments because the old ones are demonstrably in trouble. Mature industries are not producing near their capacity, and investment in them would not be profitable. The validity of this argument is uncertain, but there does appear to be a correlation between innovation frequency and the long-range business cycle. – L.G.

There are very powerful barriers to the divestiture of an ongoing technology, both personal and institutional.

Figure 2.



peting new technologies as well.

For example, by the mid-1950's it was clear that the next generation of airplanes would not rely on the internal combustion engine. Douglas and Boeing met this challenge by developing the DC-8 and the 707, respectively, both of which were turbojet driven. Lockheed, on the other hand, entered the market with the Electra, which was a turboprop.

The turbojet had significant advantages over the turboprop: more power, greater fuel economy, higher capacity, longer range, and a greater maximum speed. The result was inevitable. Boeing and Douglas dominated the market.

Lockheed's choice of technology was much less aggressive than either Boeing's or Douglas's in that it was more incremental in nature. By retaining the propeller and much of the physical configuration of earlier aircraft, Lockheed's plane did not make a successful transition to a new and superior technology.

This sort of thing happens time after time. The Japanese fueled their entry into the American consumer market by selling pocket transistor radios while American companies were still committed to larger portables. Michelin dramatically increased its share of the tire market with steel belted radials while American firms stayed with the bias tire.

In general, when a new technology comes along, some firms are able to take advantage of it, while others are not. The rewards for the winners are great, the punishment for the losers is severe. The idea of a technological discontinuity, in which a company, a nation, or even the whole industrialized world, is faced with a new technology, or a new set of technologies, permeates all levels of technological dynamics.

Technological advances are possible only because of major investments in research and development. The first thing to note about R&D dynamics is that nature sets limits on how far we can go. Nothing can move faster than the speed of light. No material can be stronger than the chemical bond. No heat engine can be 100 percent efficient. The practical, or engineering, limits are generally lower than the natural ones. Velocities are limited by the available power sources, not the speed of light, for instance. The point is that, as we try to improve a particular technological performance, there is a ceiling on what we can reach.

In the case of advances in aircraft technology, since the first powered flight, succeeding developments have taken longer and longer to implement. The most recent advance was the Concorde, which is so expensive it must be run at a loss. One wonders what the next viable breakthrough can be, if it must depend on extensions of current technology.

The second important fact about R&D is that it feeds on itself. At the beginning of a research and development effort, when little is known, progress is slow. As more information is acquired, however, advances are made at an increasing rate, until engineering and scientific limits start to be important. Further progress then becomes more incremental–and more expensive – and the technological performance curve flattens out. Thus, if the performance curve is plotted against research effort expended, again the S-curve results.

The point at which R&D productivity is at its highest corresponds to the point at which technological performance has reached half of its limiting value. This is an important concept. It means that we cannot expect ever-increasing R&D productivity for a given line of research. It also shows, however, that there is still a lot of performance left in the system, even when productivity starts to decline.

Cycles of Innovation

Having examined the dynamics of the diffusion of technology, technological substitution, and R&D projects, we can now look at technology as a whole.

A data base for technological innovation has been constructed by Gerhard Mensch, who studied 112 technological innovations. For each of these, he identified the time of innovation (defined as the time of first commercialization) and the time of invention (defined as the time of the significant publication, patent disclosure, press announcement, etc.). That is, the time of invention was the time when the feasibility of the innovation was known, and the time of innovation was the time it was put into practice.

A fascinating result emerges if the frequency of innovations is plotted against the time at which they took place, as shown in Figure 2. Innovation occurs in waves. It is far from uniform, but has pronounced, long-term variations. The interesting points to note about this plot

The exit problem is a difficult one, but it must be solved.

are the following:

☐ The crests of industrial technological innovation occurred in 1825, 1885, and 1935, right in the middle of major world depressions.

☐ The number of innovations per year is increasing with time, with each succeeding peak higher than the last. From 1825 to 1885, the peak increased by 85 percent, while from 1885 to 1935, it increased by about 35 percent. Thus, the frequency of innovation more than doubled in 110 years, but the rate of increase is leveling off.

☐ The time between crests is about 55 years. Actually, it took 60 years to go from the first to the second, and 50 years to go from the second to the third. Whether or not there is any significance to the difference between these times is unclear.

THE first wave of innovation, beginning in 1825, represents the technological growth driven by developments in electrical production, railroads, steel production, Portland cement, and pharmaceuticals, and was fueled primarily by wood, with increasing use of coal after 1830. The second wave, at around the turn of the century, depended on a group of technologies including vulcanized rubber, photography, electric motors, electric lighting, the telephone, the steam turbine, and others. The fuel during this period was primarily coal. The technologies driving the third wave – upon which the world is still riding – include the jet engine, plastics and polymers, automotive technology, and electronics, with oil being the important energy source.

During each period, a cluster of technological innovations was introduced, slowly at first, then with increasing speed, finally slowing down and leveling off – the same pattern we've seen for technological diffusion, substitution, and research and development.

The time lag between invention and commercial application varied from less than ten to more than a hundred years, but both the maximum and minimum time lags have decreased by one-half since the first quarter of the nineteenth century. If we compute the average time lag in each of the three waves of innovation, we find that for the waves centered at 1825, 1885, and 1935, the average times between invention and commercial practice were 60, 51, and 29 years, respectively.

Technological Discontinuity

As I've said earlier, our knowledge of technological dynamics is still at a rudimentary stage. Our data base is small, and there are problems even with the definitions of various kinds of technological progress. In attempting to integrate the empirical results that are available to us, it is necessary to make a bold, perhaps even a foolhardy, generalization: The intrinsic dynamics of any technological enterprise are given by the S-curve. That is, technological enterprises are born, grow, slowly at first, then with increasing speed. At some point, they reach their peak, start to slow down, and finally become static. (By technological enterprise, I mean to include research and development projects, individual technologies, groups of related technologies, individual companies, entire industries, the technology of a nation, and even that of the world – the entire range of technological activity.)

Note that the S-curve describes the *intrinsic* dynamics of a technological enterprise – the evolution of a technology left to itself. Conditions external to that technology, however, can alter the course of its evolution. We have already seen an important example of this in the development of jet engines. The turbojet, following an S-curve, took market share away from the piston driven aircraft, which decreased in sales dramatically rather than staying on its own S-curve. Meanwhile, the inferior innovation, the turboprop, was cut off from pursuing its S-curve by the superior performance of the turbojet.

The shape of an S-curve can be interpreted as the result of two opposing forces, one favoring and the other opposing technological progress. At the early stages of a new technology, only a few individuals or groups are interested in it. They see a promise, a possibility, there that is not visible to others, and pursue the technology in spite of its low level of development and lack of general support.

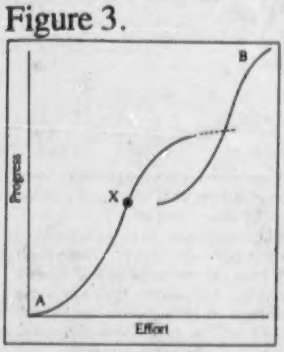
As the technology starts to succeed, others come to see its potential, and the driving force increases. New knowledge, better performance, market acceptance, and return on investment beget more interest and activity, which continually push the technology forward. But, as time goes on, further technical advances become more difficult, the investments needed become ever larger, and markets become saturated. The forces retarding growth take over, and stagnation is the result.

Clearly, a rational approach toward technological growth would be to allow a technology to expand until the bulk of its benefits have been obtained, but to plan for its finite lifetime by preparing for a new technology before the old one becomes static. In this case, conditions would be far more favorable for continuous technological and economic growth, without any major dislocations.

Unfortunately, this is not what happens. On the contrary, there are serious discontinuities in technological enterprises at every level, with disastrous results for those involved. Such a discontinuity is illustrated in Figure 3, which shows the S-curves for two technologies, one superior and following the other.

For specificity, let's describe the experience of a company as it moves along its technology curve A up to point X, where it meets competition from a better technology, represented by curve B. If Company A stays with the old technology it obviously will be in trouble. To continue its success, *it must cross the technological discontinuity*. It must abandon the old, and adopt the new, superior, technology. This is a very difficult step to take, given present planning and decision-making methods.

Figure 3.



Company A has been moving happily along its performance curve, able to do so because of enormous investments in time and money, with a concomitant organization of people with the proper expertise, a full knowledge of the technology, the appropriate marketing strategy, and a command of all the relevant business factors. Suddenly, it is being challenged to change all that, and to do it fast. The company needs to write off investments, reorganize, acquire new kinds of people, reevaluate its markets, and learn a new way of doing business. If the company fails to accomplish this, someone else takes over the leadership position.

Examples of technological discontinuities are all around us. The American automobile industry failed to jump to small car technology at the right time, thereby opening our market to a flood of imports. Our rubber industry left the introduction of steel-belted radials to others, and made Michelin a world force in tires with sad consequences for U.S. companies and their employees. Consumer electronics, large castings, large-scale tankers, electronic cameras, and energy production are all fields in which we have failed to cross a technological discontinuity successfully.

The major problem we face as a technological society is to learn how to cross these discontinuities. Unless we learn to do this, successfully and smoothly, with a minimum of dislocation and pain, we will be trapped in periodic cycles of unemployment and instability, with dangerous economic, political, and social consequences.

A major obstacle that must be overcome in this effort results from a mismatch of time scales. The decisions of our leaders and policy-makers are usually based on short time perspectives, much shorter than those characteristic of technological developments. Both rewards and punishments in our business and political systems depend on short-term performance.

The time of a great technological cycle is about 55 years; the time lag from invention to application of a technological innovation ranges from 10 to 100 years; the half-life of a new technology is 10 to 30 years. In contrast, promotions and elections for individuals in industry and government take place every year to every six years. Annual reports, budgets, and raises are on one-year cycles, while performance reviews can take place even more frequently. Stock market prices are quoted *every day*, and there is no doubt that many corporate decisions are made with an eye to the price of the company's stock. If people are being measured and rewarded for performance on this time scale, how can they include long time perspectives in their decision-making?

Another difficulty is the common tendency to believe that conditions of the recent past will continue indefinitely. The reason a new technology has few takers in its early stages is that, because the rate of progress is slow, most people believe it will continue to be slow. On the other hand, when a technology is humming along, making money and providing jobs, everyone behaves as if the benefits were going to flow forever. At the mid-point of the S-curve, the productivity of a technology is at a maximum – attracting its highest level of investment and commitment just as its productivity is about to go down. Deeper understanding of technological dynamics and an emphasis on longer time frames would restrain at least some of this foolishness.

There are very powerful barriers to the divestiture of an ongoing technology, both personal and institutional. Much of the power to make economic and technological decisions rests in the hands of people with limited knowledge of technology. Neither their own backgrounds nor current organizational structures are conducive to including technological perspectives in their strategic planning. Also, production plants geared to the old technology are in existence, the people involved have successful careers dependent on that technology, and human expectations all lean toward sticking with the old methods. The exit problem is a difficult one, but it must be solved.

The litany of technological dangers facing the world has been recited vigorously and often, especially in recent years. These dangers, ranging from nuclear holocaust to social alienation, are very real, but the benefits and opportunities of technology are equally staggering. Currently we are in the midst of the greatest discontinuous transition humanity has ever seen, and we must find a way through the complexities we face so as to avoid the dangers and reap the benefits. ■

Suggested Reading

EDWIN MANSFIELD, Economics of Technological Change, *W.W. Norton & Co., Inc., 1968. This is an excellent introduction to the economic aspects of technological change by a leader in the application of quantitative methods to the subject.*

GERHARD MENSCH, Stalemate in Technology, *Ballinger Publishing Co., translated from the German in 1979, first published in 1975. Essentially a research monograph, but very readable, this book presents Mensch's findings on innovation. It develops the long wave theory of innovation and relates it to the long waves of economic activity.*

SIMON RAMO, America's Technology Slip, *John Wiley and Sons, 1980. Ramo analyzes the great opportunities and difficulties inherent in present and emerging technologies.*

Los Angeles Unified School District

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HARRY HANDLER
Superintendent of Schools

WILLIAM L. LUCAS
Assistant Superintendent
Government Relations

March 22, 1983

Senator Robert T. Stafford
Chairperson
Senate Subcommittee on Education, Arts
and Humanities
5219 Dirksen Senate Office Building
Washington, D.C. 20510

Dear Senator Stafford:

May I again thank you and the Senate Subcommittee on Education, Arts and Humanities for allowing me to include the Los Angeles Unified School District's description of the problem it has in providing adequate instruction to students in mathematics and science. The members of the Board of Education, the Superintendent and staff of the Los Angeles Unified School District recognize the need for providing our students with high technology skills, so essential in today's work world. Our staff has identified some solutions to this problem in S.530.

In my testimony before the Committee, I referenced the partnership that has been established between educators and business leaders through the efforts of the California Roundtable. In response to your request for additional information about this partnership, I offer the following to be included in the records of the Committee.

The California Roundtable is comprised of the chief executive officers for 83 of the state's largest corporations. The Roundtable has constituted a Task Force on Education to formulate specific courses of action to raise educational standards, upgrade technical education, increase community involvement, reform the financing of education and strengthen the teaching profession. Of particular interest to the Senate Subcommittee on Education, Arts and Humanities is the set of Roundtable recommendations for upgrading technical education, as follows:

1. Help establish high quality technical education as a top priority

   The business community should persuade government, educators, and the general public that high quality technical education should be a top priority for California.

2. Support coordinated statewide planning for technical education

   The business community should support the development of a statewide coordinating body to formulate long range plans and mobilize actions for technical education in California.

3. Join with postsecondary institutions to help meet technical education crisis

   The business community and postsecondary institutions should establish a joint agenda for cooperative programs to help meet the crisis in technical education.

4. Provide short term assistance to relieve math/science emergency

   Businesses should establish company programs that provide business resources--skilled personnel, employment opportunities, equipment and facilities--to help schools through the short run math/science emergency while more comprehensive state programs are being developed. These programs could:

   a. Release employees and encourage retiring employees to teach math/science.
   b. Provide summer and part-time jobs for math/science teachers.
   c. Make equipment and facilities available to schools.

5. Establish programs to help recruit and retain high quality math/science teachers

   Businesses should establish company programs, and support similar state programs, that provide resources--funding, dual career opportunities, recognition--to teachers and prospective teachers, to help recruit and retain high quality personnel. These programs could:

   a. Provide scholarships and loans for prospective math/science teachers.
   b. Establish dual career options for math/science teachers.
   c. Establish teacher fellowship programs for outstanding math/science teachers.

6. Support programs to upgrade high quality instruction in technical education

   Business community should commit resources to the support of state and local programs aimed at upgrading the quality of instruction in technical education. The business community should help establish and/or support:

   a. Local and regional math/science high schools.
   b. Math/science institutes for teacher professional development.
   c. Teacher/resource centers.

7. Support higher pay with longer work year for math/science teachers

   The business community should support the development of a government program to provide higher pay for math and science teachers, who would in turn be required to work an 11-month year.

8. Support tougher credentialing requirements for math/science teachers

   The business community should support stiffer requirements for award of a credential to teach math or science, and tougher standards governing who could be assigned to teach these subjects.

The educators working with this particular Roundtable Task Force recognize that this particular partnership, coupled with the resources contained in S.530, would provide the schools in California with a strong foundation for improving mathematics and science in the state's 1,044 school districts.

Again, I would like to thank you for allowing me to add this letter to the Committee's record.

Sincerely yours,

William L. Lucas

WLL:su

cc: David Morris
    David Evans

Los Angeles Unified School District

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HARRY HANDLER
Superintendent of Schools

WILLIAM L. LUCAS
Assistant Superintendent
Government Relations

March 22, 1983

Senator Edward M. Kennedy
Ranking Minority Member
Senate Labor and Human Resources Committee
Room 4232, Dirksen Senate Office Building
Washington, D.C. 20510

Dear Senator Kennedy:

During the hearing of the Senate's Subcommittee on Education, Arts and Humanities on March 9, 1983 regarding math and science, you expressed concern about the access of minority students to academic achievement. I would like to take this means of communication to share with you some of the programs afforded to our minority students in the Los Angeles Unified School District. If possible, I would like to have these descriptions added to my testimony before the committee, for the record.

First, I would mention the mathematics program at Garfield High School, the enrollment of which is 99.0% Hispanic, and 99.5% combined minorities. This is the program from which 14 calculus students scored so high on an advanced college placement test by the Educational Testing Service that they were required to repeat the test to prove that the scores were, indeed, valid. I have enclosed several articles that were in the local press about the issue at that time (Attachment A).

This is but one of the many programs in the district which are providing myriad opportunities to minority students to excel in academic areas. I have also attached a list of the magnet schools in the district, with the subject emphasis indicated (Attachment B). The "highlighted" schools are those which are in predominantly minority areas. The booklet, "1982-83 Choices," gives some details about the various magnet programs (Attachment C).

I have also included information about a special program in the district directed at the identification of underachieving potentially gifted and/or talented pupils of diverse cultural and linguistic backgrounds (Attachment D). These are students who would not be identified by most traditional means of determining the gifted and talented. In just the past year, over 700 underachieving minority students have been identified as gifted/talented under this program. This is but the latest of many years' ongoing efforts to identify minority students with high potential. Overall, some 2,200 minority pupils were identified last year as being gifted/talented, out of a districtwide total of 3,700.

I have also provided descriptions of 21 instruction-strengthening programs which were developed for and are conducted in predominantly minority schools. Detailed descriptions of three of the programs are included (Attachments E).

Please let me know if I can be of further assistance in informing you about this district's commitment to and involvement in assuring that all our students are provided the best academic preparation that we are able to offer within our limited resources.

Sincerely,

William L. Lucas

WLL:nf

Attachment

cc: ✓David Morris
David Evans

Los Angeles Unified School District

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HARRY HANDLER
Superintendent of Schools
WILLIAM L. LUCAS
Assistant Superintendent
Government Relations

March 25, 1983

Senator Robert T. Stafford
Chairman
Subcommittee on Education,
Arts and Humanities
SD-428 Dirksen Senate Office Building
Washington, D.C. 20510

Dear Senator Stafford:

Attached is our response to the Panel II followup questions you requested.

I was very pleased to have had the opportunity to represent the Los Angeles Unified School District before your Subcommittee on Education, Arts and Humanities.

Our continuing concern is that we have enough resources to provide the type of service that is needed to bring all students to a level of academic and skills excellence to become productive citizens.

Again, we are encouraged by the leadership and attention you and your committee are giving to this issue.

Sincerely yours,

William Lucas

William L. Lucas

WLL:su

Attach.

PANEL II QUESTIONS

Question 1: Are there any potential pitfalls in a comprehensive federal mathematics and science education initiative? Are we neglecting other necessary subjects of study?

Response: A comprehensive initiative in mathematics and science education would, of necessity, affect several levels of instruction and training as well as various categories of students and teachers. Planners should be aware of the relationships among these factors and the effect that each has upon the other in the instructional program. The distribution of funds should be based upon careful analysis of the points of greatest need and effectiveness. If disproportionate shares of the resources are applied to higher education institutions, then school districts may derive limited benefit to the mathematics/science programs for their students. A difficulty would also occur if school districts received funds without adequate resources being provided for teacher training and development in mathematics, science and related pedagogy.

Emphasis placed upon any subject area, particularly when resources are massed in support of that subject, causes a concomitant reduction in support of other fields of study. The emphasis upon mathematics and science education, while manifestly needed in the current situation, may cause a negative response to other important subjects including English, social studies and foreign languages. Planners should be aware of the singular dimension of the math/science thrust and find means to provide a balance as the educational community responds to the emphasis. The balanced curriculum concept must be articulated, especially in terms of the interrelatedness of academic areas and the importance of balance in the academic and human application of mathematics and science. The planning for an increased level of support for math and science should include a measure of like support for other academic areas so that a balance is maintained both in resources and in attitude.

Question 2a: Should there be any intrastate distribution formula in a legislative initiative to deal with math and science education problems?

Response: If the data provided by all the experts leads to the assumption that the problem is of such magnitude that it affects all schools, then the resources to solve the problem should be made available to all schools on a pre-determined basis. The formula for distributing grant funds should be free from "self-serving" conditions, and must recognize the degree of the problem faced by each school in a district. Without a pre-determined formula, a greater percent of available funds will be required to administer any type of competitive grant program that might be developed.

Question 2a - (response continued)

If you decide that an intrastate distribution process is more advantageous to the federal government, the following formula is one you might consider:

- The State Department of Education would be required to survey each school district to ascertain the following data:
  - . The number of teachers in an individual secondary school who teach at least three periods of mathematics, science, or a combination of both subjects, and
  - . The number of these teachers who majored in Math or Science in college, and
  - . The number of these teachers who did not major or minor in these subjects in their college undergraduate work.

The percentage of teachers teaching Math/Science classes who did not major or minor in these college fields would constitute the school's "need," i.e., if a school had 7 Science teachers and only 1 majored in Science, the need factor would be 86%.

Question 2b: If we are speaking of a maximum level of funding of no more than $500 million, do we seriously dilute our effort if we require funds to be passed through to all school districts within a state?

Response: To a degree we believe the amount of money would be diluted unless some formula is utilized to allow for priority allocations based upon a factor of high need.

Question 2c: In light of several studies indicating that state distribution of Chapter II block grants more closely mirrors general enrollment patterns in states rather than patterns of greatest need, what assurance is there that states will distribute federal math and science funds to areas of greatest need?

Response: Most of the programs consolidated into the block grant under ECIA, Chapter 2, are limited to antecedent legislation which was developed by special interest groups and, in many cases, was not a "need" as perceived by the educational community at large. The distribution of Chapter 2 funds may be a true indication of a need pattern in light of the 29 "purposes" of the legislation. In addition, Chapter 2 funds may be used for in-service training, but may not be used for retraining or for encouraging teachers to return to school with a stipend. Guidelines from the funding agency will be the best way to assure that patterns of desired distribution are followed.

Question 3: Should there be any "rule of thumb" we should follow in determining the proportions of funds to be expended on teacher training, for example, as opposed to instructional equipment?

Response: A 20% - 80% rule of thumb is recommended. The 80% factor would be for teacher training and the 20% factor for instructional equipment. This formula has been used by the State of California in many of its specially funded programs. The 80-20 rule of thumb seems to be consistent with the salience of the teacher's role in the instructional process. We have viewed the teacher as the primary instructional vehicle with equipment viewed as a corollary to the teaching act. There may need to be some provision of flexibility, particularly if a grant involves a focus on computer training. The start-up grant formula might require a greater allocation for equipment if, for example, a new or rehabilitated laboratory had a high priority.

Question 4: I asked the previous panel about the question of loan forgiveness. Do you believe loan forgiveness would be an effective mechanism to help improve the quality and increase the quantity of mathematics and science teachers?

Response: Our Personnel Division processes between 300 and 400 service verifications per year for teachers who are seeking forgiveness of student loans. Although this does not speak to effectiveness, it does reflect the importance of such loans to teacher trainees.

It is believed that student loan forgiveness would be an effective mechanism to attract teacher trainees in shortage fields and would encourage established teachers to seek retraining as math and science teachers or to encourage current math and science teachers to upgrade their skills.

The cost of tuition and fees in colleges and universities has been climbingsteadily for the last few years. Students seek high paying professions which will help to offset the cost of their training. Since teaching does not, and probably will not, provide a high salary for new teachers or experienced teachers, loan forgiveness can and will serve to encourage outstanding pupils to consider teaching as a profession.

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April 13, 1983

Senator Robert T. Stafford
Chairman
Subcommittee on Education,
Arts and Humanities
SD-428 Dirksen Senate Office Building
Washington, D.C. 20510

Dear Senator Stafford:

The attached are my responses to the questions you have asked me to respond to in your letter of March 25, 1983.

Sincerely yours,

William L. Lucas

WLL:su

Attach.

cc: Senator Claiborne Pell
Senator Christopher J. Dodd
David Morse

RESPONSES TO QUESTIONS REGARDING THE ECONOMIC SECURITY ACT AND RELATED LEGISLATION

Responses from: William L. Lucas
Assistant Superintendent
Office of Government Relations
Los Angeles Unified School District
Los Angeles, California 90012

Questions for Panel 1

ANSWER: 1. The question demands the identification of a single "most significant factor" contributing to the decline in SAT mathematics scores from 1963-1980. While there are a number of factors which have contributed to the problem, it is likely that the strongest force impacting the decline in mathematics scores and academic performance in general was the societal changes that took place during that period of our recent history. Such pressures as the demand for "more relevant courses," more freedom on the part of local school districts and even individual schools to design their own mathematics and other programs, and the insistence on less rigidity in the curriculum in general undoubtedly contributed greatly to the drop in student performance.

As for concentrating efforts to overcome the problem, recent SAT scores reflect slight improvement nationwide, and many educators feel that this is directly attributable to the "back to basics" movement and the return to a more structured mathematics curriculum in most school districts. Standardization of the mathematics instructional program should be a continuing thrust; students who do not understand basic mathematics must receive additional attention; and those who do well in math should be encouraged to take advanced classes and plan for math-oriented careers, including teaching. That single thrust would do much to reinforce the current upward trend in SAT scores.

ANSWER: 2. The longtime shortage of qualified mathematics teachers at the secondary school level has resulted in the assignment of individuals from other subject fields and even from outside of the field of education to many math classes. This is the group that should receive the initial help in dealing with more than just "basic mathematics." Qualified mathematics teachers will seek to teach the higher level courses or prepare themselves to do so with little encouragement. It is likely then that two training programs should be developed: (1) one to deal with less experienced math teachers and those without adequate background to teach higher level courses; and (2) a program to assist experienced/qualified teachers to handle these courses. For the less experienced, a training program of at least a year, requiring the exercise of what is taught in the training in the teachers' own classrooms, is probably a modest effort, while teachers with better preparation to teach the advanced classes could probably qualify in much less time (two to three weeks during the summer).

Questions for Panel 1 (cont.)

ANSWER: 3. Clearly, the first priority must be preparing mathematics teachers at the secondary level to teach basic and higher level courses more effectively. However, serious consideration should be given to reinstituting programs like those that have benefited students at all levels (e.g., the Madison Mathematics Project, the Columbia Math Program, etc.). The loss of resources for programs such as these has had an extremely negative effect on mathematics instruction, K-12.

Questions for Panel II

ANSWER: 1. Few educators would argue with the need to place increased emphasis on foreign language instruction. As a rule, only students preparing for entrance into higher education take such courses, and because of budget reductions, general lack of interest, the lack of qualified teachers, etc., many of these youngsters are not provided with a full array of offerings. There is increasing recognition that a return to Latin instruction is essential. Students with a solid background in Latin are generally better prepared to deal with other languages at the college/university level and in real-life situations. Because of our proximity to Latin America, more Spanish should be taught in all schools, not just in the "border states." In an ideal world, Russian, Chinese, Japanese, Middle Eastern, and European languages should be available to students in all high schools. Again, ideally, such instruction should begin at an early age. In Los Angeles, a very successful program has been the "Language Transfer Project," an instructional program focusing on Latin language and culture for fifth and sixth grade students. Youngsters who have participated in this program are reading better, finding it easier to learn Spanish and other languages in junior and senior high school, and developing multicultural understanding. It is a program which could be profitably replicated in every elementary school in the country.

ANSWER: 2. Why not use scores on standardized measures of achievement as the basis for allocating extra resources for science and mathematics instruction? Most school districts employ the use of such instruments at both the elementary and secondary school levels, and test results alone could be utilized effectively as the basis for deciding whether or not a district's elementary or secondary schools require the most help. Another helpful basis for making such an allocation would be locally-developed proficiency test results, although these tests are not standard from district-to-district. Perhaps local districts should have the option to develop proposals for such help based on their own analysis of standardized and/or proficiency test results. This would require a district to have a defensible rationale for any such requests for additional assistance.

Questions for Panel II (cont.)

ANSWER: 3. There is no question regarding the need to address this critical issue. Since it is a costly proposition, perhaps legislation could be developed which would provide rewards to technological industries which contribute both equipment and resource personnel to school districts for such programs. In our rush to become "computer literate," we may have overlooked the need to train individuals to maintain and repair computers. Any program directed toward preparing people to work in highly technical fields should also address the need to keep the equipment working properly.

ANSWER: 4. Other than the obvious deficiencies in salaries, it is probably true that most teachers, including math and science teachers, who leave the field are disenchanted with the public's general lack of support for education and teachers' apparent lack of status. It is probably also true that those who leave teaching are finding it increasingly difficult to deal with life in an urban environment, where crime, traffic, "less supportive students and parents," and other discouraging factors, real or imagined, tend to mitigate against feelings of success and accomplishment which are so essential to continued productivity in any field of endeavor.

Factors that encourage mathematics and science teachers to stay include: providing higher salaries for teachers in these fields; offering them summer work either within the school district or in industry; and finding more effective ways to provide status and recognition for teachers. As simple a "device" as a periodic "teacher recognition day" on the part of the community can do much to encourage teachers to remain with a demanding profession. However, the "bottom line," to use an overused expression, is that nothing beats adequate financial compensation as an incentive to continue in any work. The legislation may address the problem adequately, but this is an ongoing problem that will require creative and flexible solutions over an extended period of time.

ANSWER: 5. The "technological illiteracy" referenced in this question may be largely a result of the inability of most school districts to purchase equipment, textbooks, and other instructional materials that are current and relevant. Few districts have found it possible to purchase computers in sufficient numbers to meet the needs of all students, and many districts have rushed into high technology programs without the necessary background which would lead to selection of the most appropriate instructional media. Many schools are using "pre-moon-landing" science textbooks. The increasing cost of books and other material is a serious problem. Allocations for such purchases have not remained current with inflation and other factors contributing to higher costs.

ANSWER: 5. (cont.)

The problem should be addressed at all levels, national, state, and local, and decisions to increase funding for such purchases, to establish priorities for subject fields and relating to types of materials to be purchased, and other critical factors should be based on recommendations received from the major urban school districts in the country, the districts which educate the majority of the nation's children.

Questions for Panel III

ANSWER: 1. Industry can play a number of significant roles in upgrading instruction in the public schools. One of the ways is by contributing material, hardware, software, and other instructional media to school districts, based upon identified needs and local priorities. The use of personnel from industry as resource teachers, tutors, etc., may best meet the needs of secondary school students, since it is at that level that young people begin to specialize and are required to identify majors, etc. Perhaps the greater service that the leaders and workers in industry can render to public education is to become advocates for the schools, to promote the positive accomplishments of students and teachers, and to develop ways of recognizing their achievements.

Questions for William Lucas, L.A. School District

ANSWER: 1. Of the 1,444 teachers teaching one or more periods of mathematics in the Los Angeles Unified School District's junior and senior high schools, 436 are underqualified and 461 could be considered unqualified as to their academic coursework in college. Of the 1,444 teachers, 547 majored in mathematics, 436 minored in mathematics, and 461 neither majored nor minored in mathematics. Please note the designation of "unqualified" or "underqualified" refers to preparation for teaching mathematics. Currently, the number of mathematics teachers in training at the eight campuses of the University of California is 22; and the 19 campuses of the California State University system have an enrollment of only 75 students in their math teacher training programs. The District estimates that it will need at least 600 qualified mathematics teachers, immediately, to fully staff its educational program. The lack of enrollment in the universities and anticipated loss of math/science teachers to private industry because of higher salaries is becoming a problem that all levels of government cannot ignore.

Inservice training is only a short-term solution to the problem. All agencies affected must develop long-range plans and, most importantly, a commitment must be maintained by all agencies until the problem is solved.

Questions for William Lucas, L.A. School District (cont.)

ANSWER: 2. We are in support of the concept of merit scholarships. A competent mathematics teacher must first and foremost be a mathematician and have, not only ability, but a technician's love of the subject; hence, merit scholarship.

I would recommend that "merit scholars" receiving grants under H.R. 1310 be required to take basic teacher training courses. The recommendation is based on the District's past experience during the "sputnik" era when the nation felt our first math/science teacher shortage. Schools actively recruited individuals who possessed a major in mathematics or science--from the armed forces (force reductions), private industry (reduced need in the airplane industry), and those not active in the work force; such as, homemakers, etc. "Teaching courses" proved beneficial to both the "new" teacher and his/her students. A more practical reason for requiring "teaching courses" is that these individuals will never earn certification without basic teaching courses.

I would amend the requirement that a scholarship recipient must teach two years in a secondary school after college by substituting it with a year-for-year ratio, with a two-year minimum. As an example, if a student receives three years of assistance under this Act, then he/she must give three years of service to the schools.

Los Angeles Unified School District

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HARRY HANDLER
Superintendent of Schools

WILLIAM L. LUCAS
Assistant Superintendent
Government Relations

April 14, 1983

The Honorable Robert T. Stafford
United States Senator, Vermont
Chairman, Subcommittee on Education,
Arts and Humanities
Senate Office Building
Washington, D.C. 20510

Dear Senator Stafford:

I have sent to you under separate cover answers to questions you asked which were attached to a letter from you dated March 25. Your letter dated March 30 also contained questions which were identified as Panel III questions, which I will respond to briefly below.

These answers are an opinion of a few staff members but do not have any scientific basis.

1. Do you feel that the necessity to train entry-level personnel to compensate for inadequate math and science education is a common problem to most private sector firms?

We are told that companies are concerned with students' apparent lack of academic skill preparation. Our own notion, however, is that there have been and continue to be some students who are well prepared and some who are not.

Many of our staff members believe that we could do a better job with a larger number of students if there were time to provide more follow-up attention in the early grades. Some of them also believe it would help if follow-up were initiated immediately at any time throughout a student's career.

The word "inadequate" in this question could lead to much speculation with regard to its meaning. Certainly a student who has a high school education, immediately out of school with average grades, should be expected to perform uncomplicated computations. Beyond that, companies must train for what they need. The factors which contribute to and deter learning are numerous, and with resources being taken away continuously by various levels of government, there is an increasing disparity between the expectations imposed upon public education and its ability to fulfill those expectations.

2. In your opinion, are we dangerously behind the Japanese with respect to technological literacy?

We have no way of knowing the answer to this question.

We are told that the Japanese produce many more engineers per capita than we do. We can only say that it is our impression that this country excels in technical creativity, which the Japanese do a good job of adopting, adapting, or improving.

3. What degree of sophistication in math and science will be required of our students to meet the need for skilled labor?

The degree of sophistication would depend on the labor skill to be performed. Public elementary/secondary schools prepare students for the common requirements of a wide variety of occupations and help prepare persons to be self-sufficient.

Specific skills are taught more intensely in college and/or trade schools; beyond that schooling, companies often have to refine the skills and knowledge of employees to help meet the scientific requirements of a particular workplace.

4. Do you feel that the emergence of high tech firms will create many jobs which will require low skill levels - as well as jobs that will require high skill levels - of our workforce, and what degree of mathematical competency will be required to fill these new low-skill jobs?

Service occupations will still exist. There will, of course, be another elite corps of people who are the thinkers of the high technology world, but there will still be occupations that will not require advanced trigonometry for good performance.

Persons who will be able to complete their own income tax forms correctly will probably be able to perform the tasks required of support personnel in the high technology world, which will keep such a world afloat.

Again, if I can be of further assistance to you or the Committee, please do not hesitate to call on me.

Sincerely yours,

Bill Lucas

William L. Lucas

WLL:su

GLCA

GREAT LAKES COLLEGES ASSOCIATION • 220 COLLINGWOOD, SUITE 240, ANN ARBOR, MICHIGAN 48103 (313) 761-4833

April 14, 1983

The Honorable Robert T. Stafford
Chairman
Subcommittee on Education, Arts and Humanities
Senate Committee on Labor and Human Resources
309 Senate Courts
Washington, D.C. 20510

Dear Senator Stafford:

Enclosed with this letter is a statement by the Great Lakes Colleges Association and the Associated Colleges of the Midwest on "emergency mathematics and science education improvement legislation."

We respectfully request that this joint statement be included in the Record of the Hearings your Committee held on this legislation.

Sincerely,

Jon W. Fuller
President

Enclosure: Statement of the Great Lakes Colleges Association and the Associated Colleges of the Midwest for the Record of the Hearings of the Senate Subcommittee on Education, Arts and Humanities (2)

/emc

ALBION • ANTIOCH • DENISON • DEPAUW • EARLHAM • HOPE • KALAMAZOO • KENYON • OBERLIN • OHIO WESLEYAN • WABASH • WOOSTER

Statement of the Great Lakes Colleges Association and the Associated Colleges of the Midwest for the Record of the Hearings of the Senate Subcommittee on Education, Arts and Humanities of the Committee on Labor and Human Resources on emergency mathematics and science education improvement legislation.

The Great Lakes Colleges Association and the Associated Colleges of the Midwest* applaud the attention which this Committee is giving to the recognized crisis that now exists in mathematics and science education. We have a serious national problem of quality in science education, and a national response is both necessary and appropriate.

Science, from early elementary education to the most advanced research, is a seamless web. Every part is necessary for our nation's strength and productivity. Improving the obvious problems in elementary and secondary science and mathematics education, and increasing support for basic research, will not deal with the whole problem. Attention must also be given to the vital link of undergraduate education, where teachers are trained and where scientists set their careers.

The role of our colleges in the education of scientists and of teachers of science gives us some particular perspectives which may be useful to the committee as it considers the proper national response to these problems.

We believe that H.R. 1310 speaks adequately to the emergency needs of science education on all levels and recommend your serious consideration of its contents. We particularly endorse the role of the National Science Foundation, which H.R. 1310 sets forth

*The Great Lakes Colleges Association is a consortium of twelve undergraduate liberal arts colleges: DePauw, Earlham and Wabash in Indiana; Albion, Hope, and Kalamazoo in Michigan, and Antioch, Denison, Kenyon, Oberlin, Ohio Wesleyan and the College of Wooster in Ohio. The Associated Colleges of the Midwest includes thirteen undergraduate colleges: Colorado College; Knox, Lake Forest, and Monmouth in Illinois; Coe, Cornell, and Grinnell in Iowa; Carleton, Macalester, and Saint Olaf in Minnesota, and Beloit, Lawrence, and Ripon in Wisconsin.

because we believe that the participation of scientists (to which NSF has access and the Education Department has not) in the development of all science education is crucial to the quality of content and method. Better education of teachers of science is an obvious and crucial part of the solution to our urgent problems at the elementary and secondary levels. An unfortunate trend in the training and certification of teachers has been to add more and more course requirements in the process and method of teaching. The goal has been better quality teaching. But the even more important courses in content have been crowded out. Some of the best undergraduate colleges have been forced out of teacher preparation and certification because they have been unwilling to compromise their insistence that the students gain a depth and breadth of knowledge, a requirement that does not leave time for the increasing number of other teacher certification requirements. Knowledge of science must be the first goal for teachers of science. An important clue to the problems we now have in science education is that this needs to be said at all. We deal most directly and intimately with twenty-five very good undergraduate colleges. We know from our first hand experience with our current students and from the record of our graduates that these colleges play an important role in providing the scientists and teachers of science which our society needs for the future. We were therefore very pleased to see in Mr. Knapp's introduction to the National Science Foundation's Budget Summary that he too recognizes the important role of such colleges. As he put it: "Another critical part of the link in the educational base which provides the Nation's future engineers and scientists is the small, predominately undergraduate college. A significant proportion of those awarded the PhD in science, mathematics and engineering receive their baccalaureate at these institutions." He goes on to note that "it is important that faculty of these institutions receive support and encouragement for maintaining their research capabilities." This is not the appropriate time to go into all of the issues about maintaining research capability for faculty at undergraduate colleges. We believe that we have, from the experience of our own colleges, some useful suggestions to make about this important part of the total process of science education, which may be relevant to decisions about authorizations for the National Science Foundation.

The undergraduate years are when well-prepared students choose and begin their careers as scientists and as teachers of science. As you may know, each year the American Council on Education conducts a survey of entering college freshmen. Among the disturbing findings in these surveys in recent years are that the percentage of entering freshmen who express any interest in teaching careers continues to decline, and that one of the other professional alternatives which shows the steepest decline in interest among freshmen is that of scientific researcher. It is very important that colleges and universities provide excellent instruction in the sciences and in mathematics so that their undergraduate students will be inspired in far greater numbers to choose careers as scientists and as teachers of science.

The issues addressed by H.R. 1310 are important and they are urgent. If we are to have a policy which will serve our national interests--providing us with a technically literate citizenry, with well-prepared teachers of science and with an appropriate number of research scientists--more needs to be done.

We regret that Title I of H.R. 1310 does not contain an earlier provision for "challenge grants" to match local funds for instructional scientific equipment. We also believe that the emphasis in Title II of H.R. 1310 on teacher and faculty training and retraining in areas of high technology, while all right in the very short run, may cause retooling in other areas of science and mathematics to fall short. These minor reservations do not, we feel, constitute serious differences with H.R. 1310 and we urge your endorsement of its provisions.

We thank you for the opportunity to present this statement for the record.

April 12, 1983

Statement of the Great Lakes Colleges Association and the Associated Colleges of the Midwest for the Record of the Hearings of the Senate Subcommittee on Education, Arts and Humanities of the Committee on Labor and Human Resources on emergency mathematics and science education improvement legislation.

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The role of our colleges in the education of scientists and of teachers of science gives us some particular perspectives which may be useful to the committee as it considers the proper national response to these problems.

We believe that H.R. 1310 speaks adequately to the emergency needs of science education on all levels and recommend your serious consideration of its contents. We particularly endorse the role of the National Science Foundation, which H.R. 1310 sets forth because we believe that the participation of scientists (to which NSF has access and the Education Department has not) in the development of all science education is crucial to the quality of content and method. Better education of teachers of science is an obvious and crucial part of the solution to our urgent problems at the elementary and secondary levels. An unfortunate trend in the training and certification of teachers has been to add more and more course requirements in the process and method of teaching. The goal has been better quality teaching. But the even more important courses in content have been crowded out. Some of the best undergraduate colleges have been forced out of teacher preparation and certification because they have been unwilling to compromise their insistence that the students gain a depth and breadth of knowledge, a requirement that does not leave time for the increasing number of other teacher certification requirements. Knowledge of science must be the first goal for teachers of science. An important clue to the problems we now have in science education is that this needs to be said at all.

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We thank you for the opportunity to present this statement for the record.

Senator **Stafford**. The committee now stands in adjourment until the 21st where it will convene in Rhode Island under the gavel of Senator Pell.

The committee is adjourned.

[Whereupon, at 12:45 p.m., the committee was adjourned, to reconvene on March 21, 1983.]

EDUCATION FOR ECONOMIC SECURITY ACT

MONDAY, MARCH 21, 1983

U.S. SENATE,
SUBCOMMITTEE ON EDUCATION, ARTS AND HUMANITIES,
COMMITTEE ON LABOR AND HUMAN RESOURCES,
Warwick, R.I.

The subcommittee met, pursuant to notice, at 9:30 a.m., in conference room east, Community College of Rhode Island, Knight Campus, 400 East Avenue, Warwick, R.I., Senator Claiborne Pell, presiding pro tempore.

Present: Senator Pell.

OPENING STATEMENT OF SENATOR PELL

Senator PELL. The hearing of the Subcommittee on Education, Arts and Humanities of the Labor and Human Resources Committee of the Senate will come to order.

This marks the third subcommittee hearing on S. 530, the Education for Economic Security Act and related science and mathematics legislation. More importantly, it will be the only field hearing the subcommittee will hold before taking formal action on this legislation next month.

In this regard, I would like to pay my own tribute to Senator Stafford who permitted us to hold the hearing away from Washington here in Rhode Island, and express my thanks to Skip Vallee who represents him here at the hearing.

I am very encouraged by the burgeoning congressional concern over the deficiencies that exist in the instruction of math, science, computer technology, and foreign languages in our Nation's schools. In the Senate now we have at least 10 separate bills addressing different aspects of this problem, and the House of Representatives has already passed emergency legislation in the area of teacher training.

Equally important, our President in his state of the Union address called for, "a quality education initiative to encourage a substantial upgrading of math and science education."

While I do not believe the administration's proposals are as comprehensive as necessary, I do congratulate it on the recognition of the problem and the willingness to advocate a new education program at the Federal level. I hope that all of us working together will achieve a viable legislative response.

The dimensions of the crisis with which we are confronted are immense. By the end of this decade, we will need an additional 2.5 million highly trained, skilled workers, doubling the quantity that we already have. We are in a situation now in which only one-third of our high schools require more than a year of math and science, and only one-half of the students take more than the year that is required.

This is a time in which there has been a 40-percent decline in high school credits in foreign language proficiency, and in which more than two-thirds of our States report critical shortages of math and science teachers.

The testimony we will hear today will be crucial to our deliberations in the Senate. I thank all of you for your cooperation. As David Evans, who has done so much to set this hearing up, and Chris O'Neil, from the Rhode Island Department of Education, have told some of you, we are under very intense time constraints because the social security bill is up before the Senate for a vote this afternoon, and I will have to leave at 11:30. So that means, since we have about 20 witnesses, a minimum time for each one.

I do not mean to be discourteous or seem to be rude in any way, but I do request all of you to try to hold it down as much as you can so that we can get a question or two into the record as well.

This hearing will be in printed form and made available to everyone who would like a copy of it when the series of hearings are finished.

Our first witness today is the representative of Governor Garrahy, Charlie Fogarty. Is he here? Also, Dr. Arthur Pontarelli, commissioner of elementary and secondary education, who will be accompanied by Charlie Shea, and Dr. Eleanor McMahon, commissioner of higher education, who will be accompanied by Albert Carlotti.

What I would like to do is ask each of you, if you would, to summarize the ideas that you have. I see Charlie Fogarty just coming in; if he would just come forward.

As a matter of courtesy to the Governor, we will ask Charlie Fogarty if he will come forward and lead off.

STATEMENT OF CHARLES FOGARTY, ON BEHALF OF HON. J. JOSEPH GARRAHY, GOVERNOR, STATE OF RHODE ISLAND

Mr. **Fogarty**. Thank you, Senator. On behalf of Governor Garrahy, who was unable to be here today, I would like to extend to you his thanks for holding this hearing in Rhode Island.

I would just briefly read from some of the remarks the Governor has to say.

Senator Pell, I would like to take this opportunity to welcome you to Rhode Island. I am also pleased you have chosen to conduct the hearing here with regard to the Education and Economic Security Act.

Our State, as you know, has a long and proud history of support for public education, and that support clearly exists now for efforts to upgrade the teaching in the area of mathematics, science, and computer technology. I am most pleased to be able to speak in support of S. 530. This timely and important legislation will greatly assist the States in addressing the critical challenge of educating our young people in the area of mathematics, science, and computer literacy.

These areas, as we all know, are critical to our Nation's hope of economic stability and prosperity. America is moving from an industrial based economy to an informational based economy. This change will require our citizens to be proficient and knowledgeable in skills which the majority do not now possess today.

Our future economic growth will be directly related to the ability of Americans and America to adopt to these new economic realities. The current task is the need for a firm grasp in math and sciences, the foundation of this informational based economy. We have all heard the horror stories about the technology gap, which began when half our population produces twice as many engineers. American students receive far fewer hours of instruction in math and science than do their counterparts in the other major industrial nations.

We are experiencing a nationwide shortage of math and science teachers. The quality of instruction in math and science in many schools leaves much to be desired. Clearly, it is time for education to develop a coordinated strategy to counter these developments. It would be incorrect to assume that there is no activity presently underway to address some of these needs.

Indeed, many States and organizations have undertaken or are undertaking efforts to reverse this trend. The Education Commission of the States, under the leadership of Gov. Jim Hunt of North Carolina, has formed a national task force for economic growth. This task force has set as its primary goal the creating of a national awareness of skills, attitudes, and behaviors needed by our high school graduates to give them the necessary background to meet the demands and opportunities of modern technological society.

Closer to home, Senator, as you know, we in Rhode Island have undertaken several efforts in the past year to emphasize the link between education and economic growth. I would just like to mention three of those initiatives.

First, the Strategic Development Commission: As you know this group was appointed last September and was given the charge of developing policy recommendations and to target an economic development strategy. These recommendations are designed to further the relationship between the State's educational and economic communities.

This commission, chaired by Terrence Murray of the financial group is expected to make its final report this next summer.

In October 1982, I also announced that Rhode Island would commit $8 million over the next 3 years for a program to develop and enhance computer literacy skills in every public school and institution of higher education in the State. This initiative will begin on July 1 of this year. Its purpose is to help prepare Rhode Island students for the jobs of tomorrow.

Finally, just 2 weeks ago I submitted to the general assembly a bill which would create a forgivable loan program for Rhode Island students majoring in mathematics or science that is designed to address the shortage of qualified math and science teachers.

States across the country are responding to these situations; however, these individual efforts alone will not be enough. The Federal Government has the responsibility to assist the States in meeting these challenges. The Education for Economic Security Act is a vehicle by which such actions can be initiated.

This is not a local or regional problem; it is national in scope, and it is incumbent upon the Federal Government to take the necessary actions to assure America's place in the new world economy. Our goal must be to fully develop our most precious resource, our people. We must insure that they have the skills to make our Nation second to none in technology, science, and the related fields.

We can accept nothing less, for these are the underpinnings of the future world economy. S. 530 will provide the necessary funding and coordination to help the States achieve this goal. In the framework of S. 530 and its stated objectives, individual States should be given maximum flexibility to continue their current efforts, in addition to starting new initiatives.

Senator, some individuals may quite appropriately ask if at this time in our history with substantial cuts in many important programs and with budget deficits of historic proportion, can we afford to undertake the ambitious efforts of the Education for Economic Security Act.

There can be only one response: With so much at stake for our children's future and the future of our Nation, can we afford not to undertake this effort? I have every confidence that America is willing to undertake these necessary tasks in an uncompromising fashion. Again, thank you for this opportunity to speak on behalf of this important legislation.

Senator PELL. Thank you very much, Mr. Fogarty. And I hope you will relay to the Governor our thanks to him, the chief executive of our State, for his input. I know his interest in this legislation is acute.

I think our next speaker will be Dr. Pontarelli. And I would add here that any statements will be inserted in the record exactly as if read.

STATEMENT OF ARTHUR R. PONTARELLI, COMMISSIONER OF ELEMENTARY AND SECONDARY EDUCATION, STATE OF RHODE ISLAND, ACCOMPANIED BY CHARLES SHEA, CHAIRMAN OF THE RHODE ISLAND BOARD OF REGENTS

Mr. PONTARELLI. Thank you, Senator, for the opportunity to participate this morning. We in elementary and secondary education are pleased to have the opportunity to make some comments with regard to S. 530. I am pleased also that Dr. Charles Shea, chairman of our board of elementary, secondary, board of regents is here with me this morning because this has been a topic of discussion at our elementary, secondary board for some time.

When you look at the proposed legislation, it seems to me that for many of us in elementary and secondary education, this is a turnaround in terms of the posture of the Federal Government. It is almost, as we have indicated at the board level, a review of something that happened way back in 1957 when Sputnik went up. And this is an area where we need to make a national commitment. Ready or not, that era of high technology is upon us.

And the other highly industrialized nations of the world have made a national commitment and have national policy, and it is most appropriate that we move in this direction as far as our country is concerned. It is abundantly clear to us that those of us in education know that as you move into this era, that brainpower is the element that will replace the muscle power, and that education becomes the fundamental element of change. So the national commitment, as proposed S. 530, is one that we salute and applaud your efforts.

When you look at Rhode Island and what Rhode Island has been doing, I am pleased to point out that we have a number of activities, Senator, one of which I would like to point out to you, and that is a task force that has been working on high school and college articulation.

This is one in which we have a number of people from higher education, from superintendents, from the principals' groups, from teacher groups, from boards, both the elementary-secondary and board of governors of higher ed, working diligently to do two things: No. 1, to upgrade our standards for graduation in elementary-secondary schools, and also to take a look at the admissions standards for higher education and to begin to bridge between the two so that we can increase the capability and the advances that our youngsters should be making as far as higher education, and as far as those youngsters who will be finishing high school and going into the world of work.

Some of the things that we see developing at the elementary-secondary level will be that we will be asking for more course content in math, in science, in foreign languages, and in the area of computers so that our youngsters will be asked to complete additional credits in all of these areas. When you look at that and see what is being advocated in S. 530, it seems to me that there is a perfect match.

With regard to the legislation that you are proposing, and I think that this is one of the things that you are anticipating, our comments and how we would react to the legislation, and rather than reading all of the document, let me just take a minute or two to point out some of the elements that we see that should be considered in your legislation.

First of all, the requirement for a 50-50 matching among the States and Federal Government in some instances may be a deterrent as far as the states are concerned. We are fortunate, as you have heard Mr. Fogarty indicate, that we do have in our State through the Governor's effort and through the local efforts a significant increase in many of these areas, especially in the high technology field.

There may be some States that may not be able to mount the 50-50 matching effort, and certainly some discussion needs to be developed with regard to that.

Another area of concern is how Rhode Island matches with some of the other States. And what we see in our State is not so much a need for additional teachers, but most of our teachers are onboard at the present time, and a significant effort needs to be made with regard to inservice training of teachers who are already onboard.

Our elementary teachers in math and in science and in computers, our secondary teachers, increasing their capabilities with regard to science education, with regard to math, the inservice that can be done for many of those individuals in their fields.

The third area that we would hope there would be some review would be to take a look at the role of State education agencies just as they have played a role in the inservice training and special education and in other fields, that there may be a requirement or an added emphasis with regard to State agencies and the roles that they play.

The last that I would point out is a very significant effort that needs to be made with equal educational opportunity with regard to minorities, with regard to women, with regard to other groups, especially in our State where there have been less than full opportunities for certain segments of our school population.

So these are areas that we would hope would be reviewed, and in our document we try to present some of those. And if there is anything that we can provide from a State of Rhode Island posture, you can see that our whole education community is represented here this morning.

And we thank you for the opportunity to appear.

[The prepared statement of Mr. Pontarelli follows:]

STATEMENT OF ARTHUR R. PONTARELLI, COMMISSIONER, RHODE ISLAND DEPARTMENT OF ELEMENTARY AND SECONDARY EDUCATION

Senator Pell, thank you for inviting me here this morning to present my views on your "Education for Economic Security Act," which would strengthen local instructional efforts in the areas of science, mathematics, computer education, foreign languages and vocational education.

We know that technology, with its many applications, is substantially altering the structure of the American economy today. Experts may debate the ultimate extent of the high-technology revolution, but they do agree that its impact will be significant for all of us both at work and at home. In last Sunday's business section of the Providence Journal (March 13), Chicago Tribune reporters Charles Madigan and Bill Neikirk presented the following scenario in their feature article on our country's rapid movement into the technological era, "Can America Rise to Meet a New Age?":

> - The decline of America's industrial base as key employer will continue as robotics and automation replace the worker.
>
> - The technology business will continue to grow, and along with it, employment in technology industries will increase. But the people who succeed in these industries will have a solid basic education, with an emphasis on science and mathematics.

- There will be substantial job displacement over the next two decades. Many manufacturing workers now on the street because of the recession never will be called back to work, even in a recovery, because they will be replaced by technology.

- Those people who have not succeeeded in an industrial society, for whatever reason, will find themselves even less prepared to survive in an era in which brain power replaces muscle power.

- Employers, particularly in high-technology industries, could find themselves facing a serious labor shortage because of the lack of emphasis on science and mathematics in public education.

- Society could become more polarized, with a strong upper middle class that enjoys the benefits of the new era, and an increasingly frustrated lower class that must depend on welfare-style programs for subsistence. (Emphasis mine)

After dealing over the past two years with a national administration that is preoccupied with reductions in education budgets and proposed curtailment of programs, including abolition of the U.S. Department of Education itself, I welcome this kind of constructive dialogue with the federal government. One outcome of this dialogue should be to answer the question posed earlier in the title of the Chicago Tribune article: "Can America Rise to Meet a New Age?" with the resounding response: "Yes, we must!"

We recognize your leadership together with Senator Stafford's in introducing S.530. We appreciate also the comprehensive scope of your bill, which includes foreign language improvement, computer instruction and equipment, and vocational education together with your concern about math and science instruction. We need to reemphasize foreign language in our schools and colleges for cultural and economic reasons as the United States plays its role in an increasingly competitive international economy where the development of new foreign markets is a critical link to our future economic security. At the same time, we concur with your need to tie our improved math, science, and computer instruction to industrial applications through your emphasis in S.530 on new and emerging technologies in vocational education programs.

Before commenting on specific sections of S.530, I would like to use the occasion of this morning's field hearing to report to you a relevant Rhode Island education activity that responds to some of the same concerns that underlie your federal legislation.

Pursuing for a moment the critical connection of education, particularly in science and math, to this emerging high-tech economy, a central finding of a recent study by the New York Stock Exchange says it all. Leonard Silk of the New York Times quoted the finding: "High industrial productivity in Japan . . . is largely due to the Japanese educational system." Later in that same article the comment is made:

> International surveys show that Japanese children, as a group, score much higher on achievement tests in mathematics and science than children in the United States. This is a result of higher average capabilities of Japanese high school graduates, according to the study, rather than the existence of an elite group.

According to William Freund, chief economist for the Stock Exchange, the attention Japanese people give to the development of human resources is the single most important factor in Japan's extraordinarily high rate of productivity--more important even than management techniques and partnerships between business and government.

While we in Rhode Island are very aware of your continuing interest and persistent efforts to build America's human resources through your support of federal education programs and budgets, we are pleased to witness that many of your Congressional colleagues appear to be sharing your concerns again, particularly in the areas of math, science, technology and foreign language development. Indeed, it is heartening to educators, parents and students to witness renewed Congressional attention to a variety of approaches to build up our country's capabilities in these critical areas.

Governor Garrahy has described his major initiative to upgrade computer instruction in the state: a plan calling for extensive involvement of both the Board of Governors for Higher Education and the Board of Regents for Elementary and Secondary Education. Another area that I would like to spend a few minutes on is the recommendations, one in particular, of Rhode Island's Joint Committee on School/College Articulation.

Over the past year, a Joint Committee on School and College Articulation has been meeting. This committee, created and charged by the Board of Regents, shares the full support and interest of both the Board of Regents for Elementary and Secondary Education and the Board of Governors for Higher Education. Representatives from both higher education and elementary and secondary education are members of this committee. The purpose of the committee is to make annual recommendations to the Board on how to improve cooperation between our high schools and colleges in Rhode Island. The committee has now made final its first set of recommendations, which will be going to our policy Board late next month. I will provide you with a copy of the committee's recommendations for your review.

There is one specific recommendation that I feel you should be aware of as you fashion national legislation in math, science and foreign language. The committee is strongly recommending more demanding course requirements for college-bound students in several areas, including math, science, and foreign language. Let me briefly summarize the committee's recommendations in the areas addressed by S.530:

Rhode Island High School Graduation Requirements in Math, Science, and Foreign Language

Subject	*Current State Minimal Requirements	Committee's Recommendation
Foreign Language	0 units	2 units of one foreign language (with strong urging to students that they consider a third year of the same foreign language)
Math	1 unit	3 units
Science	1 unit	2 units of laboratory science

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*It should be noted that most schools exceed the current state minimal requirements for their college-bound students.

To provide a little more background on these recommended upgradings, it should be noted that:

1) most of our public schools do not now require three years of high school mathematics as recommended by the Articulation Committee;

2) only half of our public schools now require two years of laboratory science as recommended by the Articulation Committee; and

3) slightly less than half our public schools now require two years of foreign language as recommended by the Articulation Committee. In many instances our college-bound students are counselled to take more rigorous course loads in math and science, but the students are not required to do so.

You can see, Senator Pell, that Rhode Island like many states around the country, is seriously reviewing its standards, its curriculum and its teacher certification requirements in an effort to improve our students' education. Again, you can see that your concerns about improvements in math, science, and foreign language instruction are concerns of ours, too. We feel that national initiatives like your "Education for Economic Security" measure would provide needed funds to support Rhode Island's efforts and those of other states.

I could continue for some time informing you of the status of Rhode Island education relative to your concerns as described in S.530. I am pleased that Governor Garrahy was able to provide you with a description of his critical contribution in the effort to improve instruction--his computer education initiative. But now I would like to take a few moments to comment directly on three issues relative to your bill.

First, there is a concern at both the state and local level in Rhode Island with the 50% matching requirements currently in the Pell/Stafford bill. While Governor Garrahy's initiative could give Rhode Island a tremendous head start in providing the state matching portion for the federal funds, this may not be the case in many of our states. Indeed, including our own state there are currently over 41 states reporting fiscal shortfalls of almost $8 billion dollars this year. This situation does not augur well for future federal initiatives calling for substantial matching funds.

Next, and perhaps to no one's surprise, as a Commissioner of Elementary and Secondary Education, I feel that legislation such as yours could be improved with a stronger state role. For example, in-service training activities for our current math and science teachers could be effectively coordinated at the state-level in cooperation with our higher education institutions. Similar programs in areas of computer instruction and vocational education could be more effective with state-level leadership and direction. It is my understanding that HR 1310, the math and science legislation that recently passed the House, has a significant role for the state education agency. A state role could include planning, needs assessment, and program evaluation activities. Currently, we have been providing such state-level assistance to our local districts in Rhode Island through our Local Planning and Assessment Process, our Basic Education Plan, in gifted and talented and basic skills programs, and through a project that has assisted local districts in self-assessments of their curricula and its coordination. I realize that your bill does recognize this role and provides some funds for states to work with local districts on exemplary programs in math, science, foreign language and computer instruction. But I am looking for a substantially expanded role here.

My final point is perhaps the most important. I would encourage you to keep in mind, as you move through the hearing process and on to mark-up, populations that are traditionally underrepresented in the scientific and technological fields, namely women and minorities, should be insured full involvement in the new programs fostered by your legislation. Such equity concerns should also apply to funding formulas if our commitment to equal educational opportunity is to remain the cornerstone of our public education systems.

In conclusion, let me again thank you for what you have done already by proposing this needed legislation. Thank you for coming here today to listen to us on how we think your legislation might be improved.

Senator **Pell.** Thank you very much indeed, Mr. Pontarelli, for your testimony, your suggestions, which we will go over, and for being with us.

I now ask Dr. Eleanor McMahon if she would give us her ideas.

STATEMENT OF ELEANOR M. McMAHON, COMMISSIONER OF HIGHER EDUCATION, STATE OF RHODE ISLAND

Ms. **McMahon.** He also serves as——

Mr. **Carlotti.** I would be happy to accompany her anywhere. [Laughter.]

Ms. **McMahon.** Thank you very much.

Mr. **Shea.** You also know I serve on the board of higher education, where Dr. Carlotti serves on the elementary and secondary.

Senator **Pell.** You all speak to each other?

Ms. **McMahon.** That is right, regularly.

Thank you, Senator Pell, for having this hearing here.

Senator **Pell.** You might want to pull all the mikes up toward you as you talk.

Ms. **McMahon.** And also for your role in the development of this bill. I am here this morning, not only as commissioner of higher education, but also on behalf of the board of governors and Chairman Carlotti. And I bring to this a perspective as a member of the executive committee of the New England Association of Schools and Colleges, which has concerns which are most effectively addressed by this bill. I also would like to thank you, Senator, and your staff for having invited our comments during the formative stages as earlier versions of this bill were in process.

Special gratitude to you, Senator, and to the cosponsors of the bill for the $6 million in Federal money that this act would allow Rhode Island to invest, and investment, I think, is the proper term, rather than expense; invest in, over a 3-year period, in our own economic future and in the economic future of the region and of New England; and also for the wide latitude that the act permits us in implementing its intent.

Most of all, I would like to thank you for recognizing the enormity of the economic challenge that faces the Nation, the need that we have to combine and undergird the strengths of a free capitalistic society with a coherent national policy in this area.

In a world in which our industries have been selectively and successfully targeted and in which competing nations are investing heavily in research and development as well as in strategic marketing, this legislation is critical; also, in a world in which we are experiencing a downward spiral in the shrinkage of human resources necessary to correct the negative trends that now obtain.

For example, just to cite one statistic in Rhode Island, the grand total of persons completing student teaching in either physics or chemistry and both URI and RIC during the past 2 academic years combined was one. At Rhode Island College, to give another example, in the critical areas which this bill addresses, biology, physical science, general science, mathematics, we have experienced since 1977 a 70-percent drop in the number of students in teacher education. And while our situation as a State, largely because of our demography, we do not project the same level of shortage that other

States do, undoubtedly we are not producing the number of teachers necessary to keep pace with the demands that will develop.

As Charlie Fogarty mentioned on behalf of the Governor, there are many activities in Rhode Island which are complementary to this initiative and which will be enhanced by this initiative, one of which is the computer initiative of which he spoke.

In relation to that, we have developed a three-tier preliminary plan for teacher training, but until this bill came along, one of our primary question was, How are we going to support this teacher training essential to the effective use of the equipment which would be purchased under the computer initiative?

Also, as was mentioned earlier, we have worked with the Department of Elementary and Secondary Education and the Governor's office in developing legislation which would provide $2,500 loans for up to 3 years to students who would major in areas of critical teaching shortage and who would commit themselves to teaching in Rhode Island after they earned their baccalaureate.

A special feature of this legislation is that it is complementary to the legislation proposed and would provide a dovetailing of State benefits with any Federal benefits which emerge. Also, as Arthur has mentioned, this bill is complementary to the activity of the Joint Committee on School and College Articulation, which will be presenting its recommendations to both boards within the next month.

And included in those recommendations and reflective of what is happening around the country in which about 15 States now have taken an action is a recommendation that college-bound high school students be required to take at least 3 years of mathematics, 2 years of laboratory science, and 2 years of a foreign language.

In addition, we have formed here in Rhode Island a mathematics-science teacher-supply-demand committee which is concerning itself not only with the question of what are the quantitative needs for teachers in terms of what we are presently doing, but what if we increased the qualitative demands on students? What implications does that have for projected demand?

The bill addresses all of these areas of need, preservice training, inservice training, retraining. It addresses the question of employment-based programs in all of these areas—mathematics, science, computer science, and foreign language.

So we enthusiastically support the bill. We share the concern expressed by Arthur about the State's ability to come up with the matching dollars.

I would like to close by quoting Alfred North Whitehead, who said in a period in which this Nation's investment in capital was critical: "In the condition of modern life, the rule is absolute. The race which does not value trained intelligence is doomed."

If that was true when he said it, it is even more so now. Indeed, it is prophetic in a postindustrial society in which the basic resource is not capital, not land, but information. It is certainly true that the race which does not value trained intelligence is doomed.

Thank you very much, Senator.

[The prepared statement of Ms. McMahon follows:]

STATEMENT OF ELEANOR M. MCMAHON, RHODE ISLAND COMMISSIONER OF HIGHER EDUCATION

OUTLINE OF TESTIMONY ON S.530

Since the section of the Pell bill that relates exclusively to Higher Education takes up only a page and a half of the act, I'll not bother to try to summarize the provisions. Below, however, are some points for you to consider including in your testimony at the March 21 hearing.

I. Preliminary Points

1. Here participating not only as CHE but also on behalf of Chairman Carlotti, and bringing to bear as well the perspective of a member of NEASC.

2. Thanks to Senator Pell for having staff invite comments during formative stages of earlier version of bill--and for listening to suggestions for strengthening the legislation.

II. Appreciation to Senator Pell and Co-sponsors

1. For the $6M in federal money that the act would allow Rhode Island to invest over a three-year period in its own and the nation's economic future.

2. For the wide latitude that the act permits in implementing its intent.

3. Most of all, for recognizing the enormity of the economic crisis that faces the nation:

   - the increasing intensity of international competition in markets that draw heavily on science and technology;
   - the unplanned nature of the U.S. economy and the lack of a national policy designed to stop further slippage in the nation's position relative to such countries as Japan, West Germany, and France;

- the downward spiral we're now experiencing in the shrinkage of the kinds of human resources that are necessary to correct the disastrous trend that now obtains; for example, to cite just one local horror statistic, the grand total of persons completing student teaching in either physics or chemistry, during the past two academic years combined, at both URI and RIC combined, was one (1).

III. R.I. Activities

1. *$8M computer initiative.
2. *Legislation to provide $2500 loans, for up to three years, to college students promising to teach in a critical shortage area, and providing for 75% forgiveness of such loans for those who keep the commitment and teach in one of the specified areas for five years; special feature of this state legislation: provision to dovetail state benefits with those that might be made available in future by virtue of any similar federal program that the Congress may establish.
3. A group formed jointly by the Board of Regents and the Board of Governors a year ago, known as the Joint Committee on School and College Articulation, will shortly be presenting its recommendations to both boards and will be including among them a recommendation that college-bound high school students be required to take at least three years of math, two years of laboratory science and two years of foreign language.
4. Have formed a Math/Science Teacher Supply and Demand Committee, which I have asked to document the precise nature and extent of any teacher shortages that are facing the state, and to advise me on solutions to any serious deficiencies the group can document.

IV. Summary: Enthusiastic Support for S 530

NB Concern regarding state's ability to come up with the matching dollars.

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*Probably included in Governor Garrahy's statement.

Senator **Pell**. Thank you very, very much indeed, Ms. McMahon. First, in connection with Dr. Pontarelli's remarks, I remember being in Moscow when Sputnik went up, long before I was a Senator, and the excitement the Russian people had from it in the streets—they were practically dancing around—was remarkable to behold; and also, as you point out, the beneficial effect it had on the United States because out of that grew the NDEA, the National Defense Education Act, and much of that spirit of education which made the advances of the early sixties possible.

In connection with the point you mentioned about the 50–50 contribution, that same observation has been made by other States, too, and there may be some modification here, 60–40 or 75–25, or something of that sort.

The method we have of doing a bill is we first do the draft in which we particularly take into account the input from the areas with which we Senators are most familiar on the subcommittee. In my case, it would be Rhode Island. And then when the bill is in completed form, we hold the hearings.

Then we take all the suggestions that are made in Washington or here and put them on a table and make sure that each one is considered and either adopted or not adopted, but at least considered. So I just wanted you to know that your thoughts on this will be most seriously considered.

I would like to ask Commissioner McMahon if in connection with the requirements in the high schools, did I hear you correctly to say that you are moving toward a requirement in the high schools that there be 2 years of a foreign language and 3 years of math before somebody goes to college? Or did I mishear you?

Ms. **McMahon**. Yes. This is a recommendation of the Joint Committee on School-College Articulation, and it would—it calls for—and this is subject to many layers of review before it becomes final—but it would call for a requirement for college bound students, students in college programs, college-bound programs, that they take at least 3 years of mathematics, 2 years of laboratory science, and 2 years of foreign language.

And that is consistent with requirements being framed in other parts of the country. I would note that New England did not slip as far in its exit and entrance requirement in the late sixties and early seventies as did some other parts of the country.

So we do not have as far to go, but nevertheless, this is a requirement that is on the table. And obviously, if this requirement, both in terms of the exit requirements at high schools and the entrance requirements of at least our public 4-year institutions were to take place, it would mean that we would have to be teaching—expand our teaching capacity in the secondary schools in these areas.

Senator **Pell**. Let me be sure I understand: You mean the recommendation is that no youngster would be able to go to a Rhode Island college unless he has had these required courses?

Ms. **McMahon**. Well, he would not be able to exit from a college program, and we also are encouraging the university and the college, Rhode Island College, to look at these admissions requirements. We would not change or not—we do not envision that the community college would adopt these requirements, per se, so that we would want to insure open access at that level.

But this would be the kind of thing that we would be encouraging high school students to do and colleges to require. One of the things that studies have shown is that when institutions of higher education, in California, for example, lowered their requirements back in the early seventies, high school students were very, very perceptive, and they obliged. They lowered the number of years they took of math and science and foreign language in direct relationship to the lowering of requirements.

So we feel that the time has come to look at increasing those requirements. However, we have to put that in the context of a very difficult demography in this part of the country.

Senator PELL. Well, I encourage you in this process. It would not only be classical, for example, that would have these requirements; hopefully, all high schools would.

Mr. PONTARELLI. Right.

Ms. MCMAHON. Arthur might comment on that.

Mr. PONTARELLI. We have documented in our paper and rather than taking the time to read all of that, I trust that that will be read into the record at some point.

Senator PELL. It most certainly will be.

Mr. PONTARELLI. All the documentation is in the paper that we have developed for you, Senator.

Senator PELL. Thank you.

Now, one other question here, and that is that in many other States there is a severe problem with regard to finding teachers really adequately trained in math and science. To what extent is that a problem here in Rhode Island?

Mr. PONTARELLI. At the present time, judging from the reviews that are made by our certification office, our certification office does not show a significant or an appreciable lack of teachers in those areas. But what we are trying to establish and point out in our statement, Senator, that what we need is more inservice of the staff that we have on board at the present time, so that our elementary teachers may have better opportunity to move into some of the science areas and math areas, especially in the computer areas where some have little or no proficiency at all.

And further, in our secondary areas, we are now at the point of making recommendations to our board of regents for increasing the certification requirements for teachers so that again that would be something that hopefully the inservice training through much like our old NSF, the National Science Foundation and other grants, we will have the opportunity to do additional inservice with our institutions of higher education, both in State and out of State, public and private.

Senator PELL. Now, do you think that the main bulk of money that is spent on general education should be spent on the high school or the elementary school level, or do you have a view?

Mr. PONTARELLI. No. In terms of—as far as these projects are concerned, there appears to be a significant spread in your recommendations with regard to what areas need to be covered. It seems to me that what we would like to see is that the local school districts would establish plans that over a 3-year period would indicate to us, much as we are doing with our computers, by the way, asking communities to take a look at the next 3 years and show us what levels of competency need to be developed at what grade levels, including the vocational-technical; and then the funding would go according to what the individual communities may need.

I point that out because in many of our communities, we know that they are moving along in good shape as far as secondary education is concerned, and just taking the computer technology, some communities such as East Greenwich—Providence is doing quite a bit; Cranston is doing quite a bit.

You will probably hear this from some of the superintendents, but I think that it is important that we have that equal opportunity across the board to develop the competencies at all levels, and that would probably come from a plan that would be established by the local communities and then the funding be appropriate according to the applications that they submit.

Senator PELL. Speaking of the appropriation of funds, do you think the funds should be according to the title I formula, or how would you have them distributed?

Mr. PONTARELLI. No, my own feeling is that in your proposal you have it according to the population count, and this is an area where I think that coming into our State it would be appropriate; all communities need to do this. What happens in some of the other programs, such as the chapter II funds under the ECIA, and others, there are opportunities to meet the needs of various need programs; chapter I the same way. What we are seeing, by the way, is that with some of those title I programs, such as the disadvantaged in chapter I, and the bloc grant in chapter II, is the communities are making those efforts in those areas.

Senator PELL. Good. I thank all of you. I thank you, Dr. Pontarelli. I thank you also for the help of Chris O'Neil in setting this up, and Dr. Shea; Charlie Fogarty, thank you so much for representing the Governor; Dr. McMahon, Mr. Carlotti. Thank you very much for being here.

Mr. PONTARELLI. Thank you, Senator.

Senator PELL. Now, we have a new panel on higher education with Dr. Newman, president of URI; Dr. Sweet, president of Rhode Island College; President Liston of the community college here; and, Dr. Flanagan, executive secretary, Rhode Island Independent Higher Education Association. I would like to add here too the appreciation of the subcommittee to Elizabeth Palter, director of development of the community college, who made all the arrangements for this hearing, which is, I think, beautifully done, and just as nice as nice can be.

Incidentally, if any of you in the audience cannot hear the witnesses, please wave your hand and let us know. But I presume, if I do not hear to the contrary, that everybody can hear.

Because of the constraints of time pressure, I will get started if we may, even though a couple of the panelists are not here. I think we will get started now. I would like to ask our host, President Liston, for his comments, and his full remarks will be inserted in the record, as if read. Then we will go to Dr. Flanagan.

President Liston?

STATEMENTS OF EDWARD LISTON, PRESIDENT, COMMUNITY COLLEGE OF RHODE ISLAND; AND WILLIAM FLANAGAN, EXECUTIVE SECRETARY, RHODE ISLAND INDEPENDENT HIGHER EDUCATION ASSOCIATION

Mr. Liston. Thank you, Senator, and welcome to the community college of Rhode Island.

My name is Edward Liston, president of the Community College of Rhode Island. The Community College of Rhode Island will be celebrating its 20th anniversary next year. This institution has been described as a model for community colleges throughout the Nation, since it offers a balance of technical and transfer programs at modest cost within commuting distance to all residents of the State.

Further, the Community College of Rhode Island prides itself on a relatively short response time required to adapt programs and courses to the changing needs of the community that it serves.

The Community College of Rhode Island is particularly pleased to host this field hearing on S. 520, since this bill is timely and appropriate and one responsive to the problem of maintaining a technologically competitive position with respect to Japan, Germany, and other advanced industrialized nations.

Closer to home, in Rhode Island and elsewhere, S. 530 addresses the problem of the unfortunate mismatch that we are now experiencing between the needs of the marketplace and the knowledge and the skills of our available work force. America responded to a similar crisis in the late 1950's, when Sputnik was launched, in time to close the technological gap between the United States and the Soviet Union. This has been referred to before, and I suspect it will again.

Once again, we must close the gap; this time, however, the intent should be to keep it closed. A strong Federal role is required to stregthen the training of Americans both young and old in the fields of mathematics, science, foreign language, and computer technology.

Institutions, incidentally, such as the community college, serve a large number of people who are retraining themselves in these fields. These certainly go beyond the age group of 5 to 17.

I would like to take a few minutes to recommend several ways in which I believe S. 530 can be strengthened. First, I recommend that the setaside for higher education be at least as great as the setaside for elementary and secondary education. The 65 percent-35 percent disparity is difficult to justify in view of the fact that community colleges and other postsecondary educational institutions are now providing over half of the technical training in this country.

Our needs in this country and in Rhode Island are to train new personnel to upgrade the skills of others and to retrain members of the adult population who have already passed through the school system.

The major portion of the training need is at the postsecondary level for young adults, minorities, women, and the nontraditional learner.

Second, I recommend that the committee give further consideration as to how to obtain a fair population formula for allocation of funds to States. Based on my previous argument, I reiterate that the learning population is an older population, 18 to 45, and some students are even 65 and over.

Using a youth age basis of 5 to 17 is probably not appropriate for obtaining a measure of the actual population in need of math, science, and foreign language training. In Rhode Island, the formula is actually punitive as we have an older population base.

Third, I suggest that the Subcommittee on Education, Arts, and the Humanities give close attention to incentives to private industry so that they may give more generously state-of-the-art equipment. In this sense, I am referring to legislation such as the Apple bill, which I think would be very helpful in this regard.

Fourth, in addition, I would urge special attention to the need for adequate library resources. The importance of staying current when knowledge and technical advances are so rapid is mandatory. Special attention, perhaps even a setaside, for specifically needy institutions ought to be considered.

Fifth, postsecondary institutions should be involved in planning and implementation. Participation in State planning by academic institutions will be very important to assuring timely responses to emerging needs.

In summing up, I commend the subcommittee for undertaking the new mathematics, science, foreign language, and computer technology initiative. As president of a community college, I can assure you that our institutions stand ready to join forces with the Federal Government and the educational partners outlined in S. 530 to bring America to its rightful place in this age of technology.

Thank you, Senator, for the opportunity to testify.

Senator **Pell**. Thank you very much indeed, President Liston.

And now we have—we have often heard the phrase, the Founding Fathers of our Republic. We now have with us the founding father of the community college, an old personal friend, Dr. Flanagan.

Mr. **Flanagan**. Thank you, Senator. It was about 20 years ago, about, when the Congress of the United States under your leadership introduced the Pell bills, the greatest revolution that took place in public or private education since the Land Grant College Act.

I am very pleased to be here. My name is William F. Flanagan. I am executive director of the Rhode Island Independent Colleges, for the eight 4-year degree-granting institutions that are members of our association. The reason I am here is to support your bill, S. 530, seeking to assist States in programs in mathematics, science, computers, and other areas of education.

Senator Pell, I represent institutions that are attended by approximately half of the higher education people in the State, and if it were not for this institution, perhaps we would represent more.

Senator **Pell**. Just for the record, what are the eight institutions you represent?

Mr. **Flanagan**. Brown, Providence, Bryant, Johnson-Wales, Providence College, Rhode Island School of Design, Roger Williams, and Salve.

Senator PELL. Thank you.

Mr. FLANAGAN. They are the schools that give the 4-year degrees that are nonprofit. Economically, they have approximately this year budgets of $240 million, which has an ecomomic impact on the State of Rhode Island that has been estimated at $600 billion.

There are 5,000 employees, and they represent one of the largest industries in our State.

Approximately 25,000 students attend these institutions in the 8 colleges that we represent, and thousands more attend postsecondary education in institutions that are self-sustaining. They are diverse, and they represent vocational, educational, engineering, graduate engineering in all its forms, as well as the conventional subjects of mathematics and foreign languages, and sciences, and so on.

I will not seek to evaluate all the curricula that could support your bill, all the great force that this form of higher education has on your program. I merely seek to offer to support—to offer this great resource in support of this bill.

I suppose that we have heard the era of Sputnik-like education, teacher training, adult education, retooling, all these we offer today, and hope to be a part of this valiant effort. I recall that when we had the hearings on the junior colleges, we had included the independent colleges in that service, too, under your leadership.

There are many areas which we seek to serve. There are many things we can do. We can offer laboratories that are not available to other institutions. I received a call last night that Roger Williams College would offer engineering laboratories to Rhode Island College, if they did not have them, for example. I have not seen the president to tell him.

But I see the whole problem, the whole problem of world education is summed up in some lines that I read at the Community College of Springfield, and they were written when the Arsenal at Springfield was dedicated by Longfellow. And he said that—

> Were half the power that fills the world with terror, were half the wealth bestowed on camps and courts given to relieve the human mind from error, there were no need for arsenals.

I offer you your kind of education.

Senator PELL. I thank you very much for your testimony. And following that thought up a little bit, I have always believed the real defense of our Nation are not the steel weapons and nuclear weapons that we have, but the sum total of the character and the education of our people. This really is what determines our wealth, our strength, our place in history.

I think we all share that, and I know I was very fortunate—I was chairman of the education subcommittee—and I would add, we are equally fortunate in having Senator Stafford as chairman, because he feels just the same way about education as you, Dr. Flanagan, you, President Liston, and I do. And without his help, we would have found education in a very dire state at this time.

In connection with the incentives to private industry, I think you are absolutely right. That is one of the primary reasons I cosponsored the Apple bill.

As far as the split goes, 50-50, we have not really made up our minds. We are not in concrete on it. I think some of us think that the habits—I think it was Alexander Pope who said, as the twig is bent, the tree will grow, and that we should perhaps get at a younger age to start the entrance to math and science, and that is the reason for the present two-thirds-one-third split that we have between elementary and secondary education on the one hand and higher education on the other.

However, we are not in concrete, and we will weigh your suggestion.

Some segments of the higher education community favor grants going directly from the Secretary of Education to specific institutions, as opposed to the provisions of S. 530 which directs money to a State higher education board and then from there to the institutions within each State.

I would be interested in what your separate views are. President Liston, what would be your thought on that?

Mr. LISTON. Well, my view, Senator, in a small State such as Rhode Island, would be that funds should be directed to the Office of Higher Education for distribution. I feel that would make better sense in terms of the delineation of the mission of the institutions in this State.

Senator PELL. What would be your thought on that, Dr. Flanagan?

Mr. FLANAGAN. Well, I think if it were done equitably, there would be no problem with that. Without choosing up sides, one against the other, public versus private, there is no conflict that I know except what is imagined.

Senator PELL. I think we are particularly fortunate in Rhode Island that we do work together more than is the case in other states.

In the area of vocational education, vocational training, how do you think the need for highly skilled workers in new technologies could compare with the need for workers in other industries, such as the service industries.

Mr. FLANAGAN. Oh, I think they are very important in the future.

Senator PELL. I think this comes out when you look at the ads in the newspaper, you find a tremendous amount of ads seeking people who are trained in certain fields. And yet, as you know, we have this impossibly high unemployment here, well over 11 percent.

Mr. FLANAGAN. And I would say trained at various levels; this institution, for example, which can train at nondegree or degree credit; institutions which need more sophisticated—people that need more sophisticated training in engineering can go to various institutions, Brown and Roger Williams, and so on.

Those who need higher education can go to the graduate programs in our institutions.

Senator PELL. President Liston, what would be your thoughts?

Mr. LISTON. Yes, Senator, I think those are good comments by Dr. Flanagan, and we are fortunate in having this diverse system of public and private education and higher education in the State that can do that job. From the standpoint of the economic development of the State of Rhode Island, some interesting things are being uncovered in the study that is being headed up by Terry Murray of the—president of the bank, Fleet National Bank. And that is that in terms of value added to the State—and this reflects itself downstream in income production and well-being of citizens—the growth of the service industries, such as the hotel-motel-restaurant business, does not contribute anything near the value added in direct proportion to its number of employees as does technological and manufacturing, wholesaling kinds of employment.

This is something that really is a relatively recent discovery because the concentration has been on the development of tourism in some other areas, and it is not having a significant impact on the development of the State.

So we need to find ways to make the industries that are here strong, and the jewelry industry, for example, has 50 percent of the total employment in the Nation here in Rhode Island in the jewelry industry.

So rather than turning our backs on the jewelry industry and trying to bring in high technology, let us spend a lot of time trying to make that a stronger industry. The same would be true for other areas, such as ship building and even the textile industries, which have been thought to be on the way out; there are some very successful companies in Rhode Island that need to be supported in the technological sense.

So I would see a very positive role in direct partnership between higher education and these industries in making them strong for the future of Rhode Island.

Senator Pell. I appreciate your thoughts there. I would add, incidentally, that both Terry Murray and Ira Magaziner were invited to testify here today, but were out of town, so could not be with us. Also, along this same line, I have always been struck by the fact that we are the jewelry capital of the United States, and yet when it comes to the higher education community taking cognizance of that fact, we do not do all that could be done.

In this regard, I am reminded that the reason for the Rhode Island School of Design being founded originally was basically related to the textile industry. It was originally designed to help—set up to help in the design and development of the textile industry. It has always struck me as being rather odd that jewelry design, which is just as much a creative art as textile design, that the school of design has always turned its nose up a little bit, and does not have a department of jewelry design, which it should have, under the same roof, to my mind.

For that reason, the Rhode Island jewelry industry under Dick Frankovitch and his group, has had to set up its own jewelry institute and has done a very good job in doing it. This is really a function that should have been taken up, I think, by the educational community of the State, which the School of Design would have been the logical institution.

I do not know what can be done along this line as we look ahead because we hope to remain the jewelry capital of America. I think one of the ways of remaining the jewelry capital is to be able to have the research and the design and planning that goes into it. It is very interesting because when you search into original design, you find there are very few original designs. I think supposedly there are less than 100 good jewelry designers in the United States; fresh design is even less.

And this is again where I feel the higher education community is not taking up the slack the way it should. With a new emphasis on math and science, as we are pushing for here, do you think that is going to work to the detriment of other areas, such as English and social studies?

Mr. FLANAGAN. Well, I certainly would not want to see that because after all without the philosophers, the scientists would be nothing. Without the scientists, the philosophers would be nothing. He would be a mechanic. I think that if differentiation in salary to support the scientific world or the computer operator rather than the person of literature or history or English or philosophy, we will lose the game. We will lose the ballgame. [Applause.]

Thank you. Mr. Kapstein used to teach for me. [Laughter.]

And he has tenure, I understand.

I really believe it would be a shame to give the State the idea that we are going to throw money to people more for this than for that.

Senator PELL. You are right. I guess the old idea of Plato's was pretty accurate: the best country, the best republic was where you had the philosopher king. He did not say the scientists.

Mr. FLANAGAN. Oh, sure. We are always fortunate to have liberal arts people in the Senate. [Laughter.]

Senator PELL. I would agree with you. [Laughter.]

No, I mean——[Laughter.]

I thank you both for your——[Laughter.]

I thank you very much.

Mr. FLANAGAN. Thank you, sir.

Senator PELL. Great. Thank you, President Liston. And thank you for letting us be here, too. It is very nice of you indeed.

Now we come to a panel on general education: Mr. Edward McElroy, president of the Rhode Island Federation of Teachers and president of the AFL-CIO; Mr. Herman Coleman, executive secretary of the NEA in Rhode Island; Mrs. Elizabeth Kenyon, president, Rhode Island Association of School Committees, and member, incidentally, of the South Kingstown School Committee; Mr. Burton Froberg, executive secretary, Rhode Island Association of School Superintendents; Sister Marie Andre Guay, superintendent of diocesan schools; Dr. Donald Gainey, president, Rhode Island Association of School Principals and principal, West Warwick High School; and, Ms. Joanne Corbett, legislative chairperson, Rhode Island Congress of Parents and Teachers, Warwick.

Would those all come forward on the panel, then. I guess Mr. McElroy is not here yet. He will probably be joining us a little later. Mr. Herman Coleman, executive secretary of the NEA is here. Is he not here, too?

OK. Well, then, Ms. Kenyon, she is here, and welcome, president of the Rhode Island Association of School Committees and member of the South Kingstown School Committee.

STATEMENTS OF EDWARD McELROY, PRESIDENT, RHODE ISLAND FEDERATION OF TEACHERS, AND PRESIDENT, RHODE ISLAND AFL-CIO; HERMAN COLEMAN, EXECUTIVE SECRETARY, NATIONAL EDUCATION ASSOCIATION, RHODE ISLAND; ELIZABETH ANN KENYON, PRESIDENT, RHODE ISLAND ASSOCIATION OF SCHOOL COMMITTEES, AND MEMBER, SOUTH KINGSTON SCHOOL COMMITTEE; BURTON FROBERG, EXECUTIVE SECRETARY, RHODE ISLAND ASSOCIATION OF SCHOOL SUPERINTENDENTS; SISTER MARIE ANDRE BUAY, SUPERINTENDENT OF DIOCESAN SCHOOLS; DONALD GAINEY, PRESIDENT, RHODE ISLAND ASSOCIATION OF SCHOOL PRINCIPALS, AND PRINCIPAL, WEST WARWICK HIGH SCHOOL; AND JOANNE CORBETT, LEGISLATIVE CHAIRPERSON, RHODE ISLAND CONGRESS OF PARENTS AND TEACHERS

Ms. KENYON. Good morning. I want to thank the chairman for the opportunity to testify this morning. I want to say that I am coming from two different perspectives this morning, both as a member of the local school board for 10 years and president of the Association of School Committees, but also for the past 8 months I have had the opportunity of serving on a task force of the National Science Foundation on precollege education in math, science, and technology.

This has been a very enlightening experience. I will not belabor the need for this type of help to our school districts or repeat the statistics. You know them. Senate bill 530 has many features that are attractive to local school boards.

The fact that the money will go to school districts according to the number of students between the ages of 5 and 17 and not be competitive grants is both equitable and appropriate. Most importantly, the bill appears to offer school districts the opportunity to decide how they can best use the money for the math, science and technology, and foreign language programs in their district.

I want to emphasize that all school districts have different needs in these areas. Some may wish to use the resources from this bill to increase their teaching staff. Some may wish to upgrade their lab equipment or computer hardware. Others may wish to develop new curriculum o provide inservice training for their staff.

I would strongly urge you, Senator, to do all that you can to see that the present latitude of the bill in this area is not restricted.

I commend you for not leaving out funding for elementary schools. This may be the area where science, in particular, is the most neglected and needs the most help if we are to inspire our students to like science and to continue to take courses in science in secondary schools.

There are two provisions of the bill which disturb me. One is the provision that there must be 50 percent matching funds. I can assure you that many school districts have such financial problems at the moment that they will be unable to take advantage of the funds from this bill. And this presents a question of access or equality of opportunity.

The other problem is an omission. I would like to see some money set aside in this bill for stipends for teachers to attend summer institutes to upgrade their skills in math, science, and technology.

Thank you.

Senator PELL. Thank you very much, indeed.

And now Sister Andre.

Sister ANDRE. I would like to thank you, Senator, for this opportunity to testify in this matter of critical concern to all educators and especially to our children. This testimony is presented on behalf of the Catholic schools of the Diocese of Providence, which number 63 elementary schools and 13 secondary schools, enrolling 23,761, or 17 percent of the total number of students enrolled in the elementary and secondary schools in the State.

We strongly support the thrust of this bill, which is to improve the instruction of students in math, science, computer technology, and foreign languages and to enhance teacher qualifications in these areas. We would like to see teacher education programs strengthened by incorporating better courses in mathematics and science education for every elementary schoolteacher.

Reading courses are required for persons seeking education degrees. Why not require strong math and science courses as well? The need for the development of strong math, science, and computer programs at the elementary school level, I feel, is critical.

Children who receive a strong background in these areas, as Ms. Kenyon said, when they are young, are more apt to select and to enjoy high school courses in mathematics and science because they are secure in their understanding of the basics.

It is my observation that many teachers in grades kindergarten through grade 8 are not adequately prepared in those areas which your bill addresses. Knowledge of and a facility in the use of computers are most important for the teacher of today.

Our teachers need to be retooled or this generation of children will be totally unprepared for the world they will encounter as adults. Anything that you can do to strengthen opportunities for inservice and computer science in your bill will be most important.

Also of concern is that the opportunity be made available to teachers not now teaching mathematics, science, or computer science to have summer courses or inservice programs provided.

We heartily support the provision of the bill which provides for the equitable participation of private elementary and secondary school children. I would suggest that with reference to instructional materials, allocations to school based on per capita enrollment be considered. For example, if the public schools receive funds equivalent to $10 per pupil for the acquisition of instructional materials and for the teaching of mathematics, science, foreign languages, and computer technology, that allocations be made equitably on a per pupil basis for private schoolchildren. This is done in chapter II and has proved to be very beneficial

All schools are finding the purchase of computers to be a great need, yet cost prohibitive. If all students, whether they are educated in public or private schools, are to be contributing adults in a future technological world, then help is needed in terms of funding sources so that all children will be benefitting.

The old NDEA provided inservice and summer programs to many public and private schoolteachers, and our students benefited greatly from the provisions of this act. I support those parts of your bill which emulate the NDEA provisions.

If some attempt could be made to provide low cost loans to college students pursuing math and science degrees for which payment is forgiven, for example, at the rate of 25 percent each year of teaching in the elementary or secondary schools, I feel that this would be a strong incentive for young people considering teaching as a profession.

Technological companies are attracting math and science majors and are giving them salaries much higher than we can afford to pay in education and are giving salaries which make the repayment of loans more feasible for them. This, I believe, is the reason for the critical shortage that we now have of math and science teachers in our schools.

Again, Senator, I thank you for this opportunity to speak.

Senator PELL. Thank you very much.

Ms. Corbett?

Ms. CORBETT. Thank you, Senator, for inviting us to speak at this hearing that is so important to the students of our State. We know there is a shortage of skilled workers in the United States, and we also know there is a shortage of mathematics and science teachers.

Your Education for Economic Security Act addresses these problems. I represent an organization whose first concern is children. Therefore, we are pleased your bill specifically states that funds will supplement moneys for education. Using the the State department of ed as administrator, there should be cooperation between higher ed and secondary schools; including foreign languages is a positive point in this legislation.

Also encouraging the schools to work with community organizations is a step toward involving the community in our educational needs.

While we endorse the concepts of the bill, we have concerns and questions. First of all, there is no provision for assessing the needs of the Rhode Island community. Would matching funds be fair to Rhode Island communities? Many districts are having difficulty raising the funds to operate their schools. Would larger communities benefit more than smaller communities if the size of a program is considered in receiving dollars, when larger school districts are more likely to have experienced personnel in grant writing and writing programs.

This program should be an ongoing one. An evaluation process should be included in this bill. The evaluation team should have representatives from the teachers, administrators, the business community, and parents. An ongoing commitment from the Federal and State governments is needed to prepare its citizens for the future. This is a step in the right direction.

Thank you again.

[The prepared statement of Rhode Island Congress of Parents and Teachers follows:]

PREPARED STATEMENT OF RHODE ISLAND CONGRESS OF PARENTS AND TEACHERS

PTA/RI believes there must be a federal committment to assist state and local education agencies in meeting the shortage of skilled workers in the high technology fields.

Recent studies by science and technology experts and reports from business and industry indicate that the United States, while in the midst of a recession with unemployment at its highest level since the Great Depression, is not producing enough citizens with the knowledge and skills necessary to compete in an increasingly technological world. During this decade alone, it is reported that the United States will face a shortage of two and one half million skilled workers for high technology.

Meanwhile, in the United States today we have a critical problem with respect to the numbers of students who take science and math courses needed to prepare for high technology careers. Only one half of the states currently require students to take even one science course before high school graduation. A shortage of science and mathematics teachers exists. In the past ten years, the number of mathematics teachers graduated from college has declined by seventy seven percent and that of science teachers sixty five percent. Of the qualified math and science teachers, twenty-five percent say they will leave their prof essions for higher paying non-teaching jobs.

Being aware of these facts and given the emphasis Japan, Germany and other countries have put on high technology, we are delighted that Senator Pell has introduced a bill that addresses the crisis we are facing in math and science education future.

First and foremost, we would like to commend the Senator for explicitly stating that the funds recieved will be to supplement not supplant State monies targeted for the improvement of education. Using the State Department of Education as the administrator facilitates cooperative and collaborative arrangements between higher education and secondary schools. The clause encouraging the schools of higher learning to work in cooperation with community based organizations such as libraries and museums is an important step in involving the community to be made aware of our educational needs.

Also, we are pleased that Senator Pell addresses the decline in students taking a foreign language. To compete in the international marketplace we must emphasize the importance of foreign languages and to encourage our students to participate.

While we heartily endorse the concepts put forth in this bill, we have some concerns and questions.

Is matching funds in the best interest of all Rhode Island communities? Some of the smaller districts are having difficulty in raising funds to operate their schools. Would other areas of education suffer budget reductions in these economically difficult times because of matching funds?

There is no provision for assessing the needs of the Rhode Island communities. Would larger communities benefit if the size of a proposed program is taken into account? Would larger school districts with more experienced personnel in grant writing have an edge in recieving funds?

As advocates of children and supporters of public education we believe every child should have the opportunity for equal access to services, use of equipment and materials. But given the limited resources available, should federal dollars be given to private schools? The administrative cost is borne by the local public school community and there is no accountability from the private school sector.

A long range committment is needed. This bill is a limited one and should address the need for evaluation and a continuing program. In the evaluation process, we believe, that the business community, teachers, administrators and parents should have input.

There must be an ongoing committment between the federal government and the state government working toward an increased effort to prepare its citizens for high technology occupations in business and industry for the nation's defense.

Senator PELL. Fine. Now, if Mr. Gainey could testify.

Mr. GAINEY. Thank you, Senator.

First of all, I would like to mention that we are very pleased to be able to testify here for two reasons: One being the fact that we have the opportunity to address an individual who has been a true champion of education and a recognized leader on a national scale.

Second, I have the opportunity to address an issue that is of concern to both the Rhode Island Association of School Principals and the National Association of Secondary School Principals, namely, the math-science issues.

We feel that greater efforts in the recruitment and retention of qualified teachers, as well as the development of methods and materials to deliver stronger mathematics and science programs at the elementary and secondary levels must begin immediately.

We feel that the statistics that we have indicate that there has been a downward trend in both math and science instruction, and that it is essential if our great Nation is to remain competitive in the world of rapidly changing industrial and technological advances.

It would seem that the time has come for us to establish local, regional, and national goals, both short term and long term, and policies which will focus upon the reconstruction of science and mathematics education. Together the Rhode Island Association of School Principals and the National Association of Secondary School Principals endorse national legislation to inspire new blood into our math and science classrooms.

Such legislation must assist school districts in providing training and retraining of the present elementary and secondary teachers in math and science. It must enable the universities and colleges to provide services to experienced teachers which broaden their perspectives, and the application of math and science knowledge and strengthen their teaching skills.

It must enable school districts to upgrade and modernize their curriculum and provide the flexibility for the purchase of appropriate equipment, including laboratory equipment.

As you know, the NASSP has worked with and supports Representative Carl Perkins' bill, H.R. 1310, which provides for these potential solutions.

Finally, we feel that the national initiative must stimulate stronger relationships between business and schools via tax incentives which allow schools and industry officials plenty of latitude to find cooperative relationships. Our schools and industry officials must be allowed to pursue the most appropriate line of cooperation which would allow teachers to learn the latest applied uses of technology. By placing teachers in a competitive income bracket, the likelihood of their leaving the school for purely financial considerations would be lessened.

Once again, we have worked with and supported Senator John Glenn's bill, S. 290, which would make this initiative possible.

In conclusion, we urge swift enactment of a new program to assist our schools in the area of math and science and pledge to work with you to achieve these goals. Hopefully, such a program will prevent a majority of high school graduates from becoming members of the fastest growing minority group in the United States, and scientific and technological illiterates.

I thank you for the opportunity to share our views in how our schools can be assisted—of assistance to you.

Thank you, Senator.

[The prepared statement of Mr. Gainey follows:]

PREPARED STATEMENT OF DONALD D. GAINEY

My name is Donald Gainey. I am the President of the Rhode Island Association of School Principals and a member of the National Association of Secondary School Principals. As president of the RIASP, I represent both elementary and secondary school administrators in the private and public sectors of the State of Rhode Island. I am particularly pleased to testify before you today for two reasons. First, in speaking on behalf of the RIASP and the NASSP, I have the opportunity to testify before the Honorable Senator Claiborne Pell from my home state, who has always been recognized as a true champion of education, and an individual who is respected for his leadership in this field on the national level. Second, I have an opportunity to address an issue that both the RIASP and the NASSP feel is critical on both the regional and national levels. While the focus of the problem may be different from region to region, the rapid and ever changing impact that technological advances have made on industry and the economy have dictated a national concern with regard to math and science instruction at all levels of our educational process.

The solutions to our problems are not simple. However, we submit that steps to improve the current state of affairs lie in our educational institutions and, more specifically, upon the sound foundation built in our elementary and secondary schools. Greater efforts in the recruitment and retention of qualified teachers, as well as the development of methods and materials to deliver stronger mathematics and science instruction at the elementary and secondary levels, must begin immediately.

Before I develop more fully our potential solutions to this problem, I would like to mention some alarming statistics which we feel will point to the critical nature of the problem both in the State of Rhode Island and nationally.

During the past decade, there has been a marked decline of math and science instruction nationally. In a report based upon 1980 information obtained from a sample of 1,100 high schools and 28,000 senior graduates, Dr. Paul Hurd of Stanford University found that while approximately 67 percent of the seniors completed two years of mathematics, only 34 percent completed three years. Similar statistics were identified for science, in that only 44 percent of the graduating students complete two years of science and 41 percent completed three or more years.

At the same time, the National Science Board Commission on precollege education in mathematics, science and technology noted that student achievement has decreased in mathematics and science as indicated by declines in the science achievement scores of U.S. 17-year-olds as measured in three national assessments of science (1969, 1973, and 1977). Mathematics scores of 17-year-olds also decreased as measured in two national assessments (1973, 1978) with the decline in the areas of problem-solfing and applications of mathematics being especially severe. On the basis of these findings, it should not be surprising that the mathematical scores on the Scholastic Aptitude Test (SAT) stadily declined over an 18-year period through 1980 from 502 to 466. Furthermore, this problem is more accute in Rhode Island where the SAT scores are below the national average. Finally, remedial mathematics enrollments at four-year institutions of higher education increased 72 percent between 1975 and 1980, while total student enrollments increased by only seven percent.

With this quantitative data clearly indicating a decline in math and science instruction, the National Science Board pointed out that among certified teachers of high school in these disciplines, very few have had the formal educational preparation required to provide students with an understanding of modern technology. Compounding this situation is the realization that there are few inservice programs or opportunities for certified mathematics and science teachers to update or broaden their skills and backgrounds. Dr. Scott Thomson, Executive Director of the NASSP, clearly articulated our position regarding this dilemma by stating that teachers of math and science need opportunities to upgrade their understanding of the rapidly changing technologies and their use in industry, for it is at the elementary and secondary levels of a youth's education that both competence and academic self image take root.

We feel that a reversal of this downward trend in math and science instruction is essential if our great nation is to remain competitive in a world of rapidly changing industrial and technological advancements. The key to such a reversal is the classroom teacher. Yet there is evidence that there is a severe and growing shortage of mathematics and physical science teachers in the nations secondary schools. In a survey including 44 states in 1980, Dr. Hurd revealed that 28 states had a shortage in mathematics, and in 16 states the situation was listed as critical. For 1981-82, 27 states reported a critical shortage of physics teachers and 15 more states reported a shortage. Although Rhode Island, at the present time, does not appear to have a shortage in these areas, I have personally noted very few teacher applications in the math and physical science disciplines for my school district.

Additionally, the decline in student teachers in the math and science areas, which I have witnessed in recent years, tends to substantiate in Rhode Island the results of a ten-year survey (1971-1980) of 600 colleges and universities with teacher training programs. This study revealed a 77 percent decline in the number of secondary school mathematics teachers being trained and a 65 percent decline in science teachers. More critical was the fact that of those trained to teach mathematics or science, a decreasing number to into teaching, choosing business or industry instead. This unfortunate reality is primarily the result of the economic wage differentials between school districts and industry.

In the past few years, I have spoken to an increasing number of teachers who have contemplated or actually made the transition from teaching to industry based solely upon economics. I have also witnessed the elimination of the Future Teachers Club at my school due to declining student interest.

In a recent survey of my senior class of 250 students, only 33 students indicated an intention of pursuing post-secondary education in the fields of mathematics or science and none of these students planned to teach.

It would seem apparent then that we must establish local, regional and national goals and policies which will focus upon the reconstruction of science and mathematics education. Together, the RIASP and the NASSP endorse national legislation to inspire new blood into our math and science classrooms. Such legislation must assist school districts in providing training and retaining of the present elementary and secondary teachers of math and science. It must enable universities and colleges to provide services to experienced teachers which broaden their perspectives and the application of math and science knowledge, and strengthen their teaching skills. It must enable school districts to upgrade and modernize their curriculum and provide the flexibility for the purchase of appropriate equipment, including laboratory equipment. As you know, the NASSP has worked with the supports Rep. Carl Perkins' bill, H.R. 1310, which provides for these potential solutions.

Finally, we feel that national initiatives must stimulate stronger relationships between business and schools, via tax incentives which allow wchool and industry officials plenty of latitude in finding ways to cooperate. Our school and industry officials must be allowed to pursue the most appropriate line of cooperation which would allow teachers to learn the latest applied uses of technology. By placing teachers in a competitive income bracket, the likelihood of their leaving the school for purely financial considerations would be lessened. Once again, we have worked with and supported Senator John Glenn's bill, S-290, which would make this initiative possible.

In conclusion, we urge swift enactment of a new program to assist our schools in the areas of math and science, and pledge to work with you to achieve these ends. Hopefully, such a program will prevent a majority of high school graduates from becoming members of one of the fastest growing minority groups in the United States, the scientific and technological illiterates.

I thank you for the opportunity to share our views about how our schools can be of assistance in solving this national crisis.

I would be pleased to answer any of your questions.

Senator PELL. Thank you very much indeed, Mr. Gainey, and I enjoyed our conversation in Washington just a couple of weeks ago, too.

Mr. GAINEY. Thank you.

Senator PELL. Now, if Mr. Froberg, the executive secretary for the Rhode Island Association of School Superintendents would take the mike.

Mr. FROBERG. Senator Pell, we thank you very much for extending to us the invitation to participate in this hearing. I am accompanied today by Myron Francis, superintendent of our association. On his behalf, I am submitting a statement for the record in addition to my own.

Senator PELL. It will be printed as if read.

Mr. FROBERG. I also am submitting for the record an article that appeared in yesterday's Providence Journal, "The United States Schools Fail to Meet Future's Challenge." I thought there were some areas in that article that might be helpful to you and your committee in the deliberation of this bill.

Senator PELL. I would also ask that there be inserted in the record the article in the current Business Week, March 28, which has an excellent article on the same subject. It was drawn to my attention by Mr. Carlotti.

Mr. FROBERG. Before I continue, I would like to take a minute to thank you, Senator Pell, for your support, interest, and continued leadership in sponsoring and supporting legislation that has been so beneficial not only to Rhode Island, but to our entire Nation.

There are two Rhode Islanders in particular who represented us in Congress who have stamped their mark in Federal educational activities: the first, a man who was a close friend, the late John Fogarty, was a leader in the House of Representatives in education for the handicapped.

Senator PELL. And the record should show that his nephew testified here earlier this morning on behalf of the governor. So the tradition goes from generation to generation.

Mr. FROBERG. Yes. His activities in the area of the handicapped, Public Law 874 in vocational education, as well as others.

The second is yourself, Senator Pell. Legislation you have sponsored has provided an educational opportunity for an untold number of postsecondary students, who otherwise may have not had the opportunity to continue their education. Your continued assistance—insistence for adequate funding for general education, special education, vocational education, adult education, and postsecondary education has been consistent.

This act, S. 530, is an example. We are most grateful.

The technological revolution, as you know, is upon us. By 1990 one-half of our Nation's gross national product will be generated by high tech industries with five out of six high growth jobs found in computer related fields. This will undoubted place a strain on our supply of additional scientists and engineers.

As you are aware, student enrollment in these fields is nowhere near the level that is needed. Although there is a variety of explanations for this, one observation is that a predominant factor is there has been a long term systemic problem in our precollege science and math education. While teachers are both qualified and dedicated, a surprisingly large number lack the opportunities to review new developments and technologies so necessary in sparking enthusiasm in the subject area in these students.

A shortage of teachers in these areas also exists because the salaries offered in private industry far outweigh those in education, resulting in fewer young people going into the profession. A reduction in our school population with a resulting reduction in staff demonstrates the need for retraining teachers in these technological areas.

Another factor is that some methods of improving instruction in math, science, and computer technology have associated costs. Like other public agencies, schools have been caught up in the squeeze of rising prices and operating costs and decreasing revenues. At present, according to the Advisory Counsel on Intergovernmental Relations, 46 States have laws eliminating taxes. But since 1977, 29 States have passed new laws that limit both expenditures and taxes; for example, proposition 13 in California or Two and a half in Massachusetts.

These laws render public agencies less able to respond to inflation and extraordinary cost increases. Schools currently spend 80 to 85 percent of their budget on employees' salaries and benefits, and thus have only limited funds to cover new training for employees or new facilities and equipment, such as science labs, science equipment, and computer related equipment.

With the foregoing in mind, I turn to S. 530. We have some concerns. $400 million is the authorization with 65 percent being allocated for elementary, secondary, and vocational education. This would mean a total of $260 million in the area of elementary and secondary schools. $260 million is simply not enough to help 16,000 school districts improve their instruction in math, science, computer technology, vocational education, and foreign languages, as well as develop an adequate pool of qualified teachers.

Spread evenly across the country, $260 million would amount to about $5 per student; certainly not enough to sustain the broad national effort. We believe it is seriously underfunded.

Senator PELL. Will you please pass that message to President Reagan.

Mr. FROBERG. Another concern is the 50-50 matching provisions. With limited resources available, together with the previously mentioned expenditure limitations in many States and school districts, it may be extremely difficult to raise the matching requirement. It may result in the affluent districts getting the funds.

The districts unable to obtain matching funds—and those are usually the ones that need it the most—will be unable to benefit from this act.

Our parent organization, the American Association of School Administrators, feels that Congress could help us a great deal by directing the National Institute of Education to conduct a series of studies on the math and science area so we can develop our information base. But AASA suggests that the NIE studies be funded from the regular NIE appropriation and not from such acts as S. 530 or similar legislation.

NIE should provide information to determine where teacher shortages are and how severe they are. The impression of AASA is that the shortage of qualified teachers is not evenly distributed. NIE scholars should also work with industry and the Pentagon to identify the skills required for future workers and military personnel and what proportion of the population will need these skills so that we will not waste resources teaching students the wrong skills.

Also, NIE should develop a knowledge base about computers because the computer seems to be driving the revolution in math and science. For example, we should determine how to use computers best as an instructional tool and for which students.

Millions of dollars are being invested in computers when all the experts agree that we do not know how to use computers best for all students and for all courses. Computers are a fact of life, but the manfacturers have not invested much in educational software because they are not sure of a return on their investment.

If schools are to select the right machines and software to meet student needs to answer these tough questions, we will have to discuss them for years to come. It is also observed that S. 530 provides little or no funds for the administration and evaluation by the State departments of education. Again, with limited resources available at the State level, some funds should be available for these purposes.

We also have a concern relative to the distribution of funds. We understand clearly the allocation of money based on the numbers of schoolchildren in the district, but we just are not fully knowledgeable as to what is meant by the size of the proposed program in terms of the number of students to be served and the number of grade levels involved in the program.

We also have some concerns as to the regulations that may develop from this particular act. So often regulations deter the effectiveness of the intent of the act; we hope that this does not occur.

While not a Federal responsibility, we urge the States to reexamine their teacher certification requirements so as to better utilize persons in our industries with technological expertise.

Again, we thank you for the opportunity to be present today, and we wish you well in this very much needed legislation.

[The prepared statement of Mr. Froberg and the article referred to follow:]

STATEMENT OF BURTON FROBERG, EXECUTIVE DIRECTOR

Mr. Chairman, members of the Committee, my name is Burton Froberg, Executive Director of the Rhode Island School Superintendents' Association. I am here today representing the Rhode Island School Superintendents' Association of school superintendents in Rhode Island. I am accompanied by Myron Francis, Superintendent of Schools of East Providence and President of the Association.

I am pleased to be here representing RISSA today because assuring adequate financial assistance to States in order to strengthen instruction in mathematics, science, computer education, foreign languages, and vocational education is essential for the nation's security and economic future.

Before continuing I would like to take a minute to thank you Senator Pell for your support, interest and continued leadership in sponsoring and supporting legislation that has been and is so beneficial not only to Rhode Island but the entire nation. There are two Rhode Islanders in particular who represented us in Congress who stamped their mark in Federal Education Activities. The first, a man who was a close friend, the late John Fogarty was a leader in the House of Representatives in education for the handicapped, Public Law 874, Vocational Education and others. The second, is yourself Senator Pell. Legislation you have sponsored has provided an education opportunity for an untold number of post-secondary students who otherwise may not have had an opportunity to continue their education. Your continued insistance for adequate funding for general education, special education, vocational education, adult education and post-secondary education has been consistant. This Act S530 is an example. We are most grateful.

The "technological revolution" as you know, is upon us. By 1990, ½ of our nation's GNP will be generated by high-tech industries with 5 out of 6 high growth jobs categories found in computer-related fields. This undoubtedly will place a strain on our supply of mathematicians, scientists and engineers. It has been stated that over the next decade the demand for scientists and engineers is expected to increase by over 40%.

As you are aware, student enrollment in these fields is no where near the level that is needed. Although there is a variety of explanations for this, one observation is that a predominant factor is --- a long-term systemic problem in our precollege science / math education. While teachers are both qualified and dedicated, a surprisingly large number lack the opportunity to review new developments and technology so necessary in sparking enthusiasm of the subject area in their students. A shortage of teachers in these areas also exist because the salaries offered in private industry far outweigh those in education resulting in fewer young people going into the profession. A reduction in our school population with a resulting reduction in staff demonstrates the need for retraining teachers in these technological areas.

Another factor is that some methods of improving instruction in math, science and computer technology have associated costs which the schools are not in a good position to pay. Schools, like other public agencies have been caught in the squeeze between rising prices and operating costs and decreasing revenues. At present, according to the Advisory Council on Intergovernmental Relations, 46 states have laws limiting taxes, but since 1977, 29 states have passed new laws that limit both expenditures and taxes (for example Proposition 13 in California). These laws render public agencies less able to respond to inflation and extraordinary cost increases. Schools currently spend 80-85 per cent of their budget on employee salaries and benefits, and thus have only limited funds to cover new training for employees or new facilities and equipment such as science labs, science equipment and computer related equipment.

With the foregoing in mind I turn to S530. We have some concerns.

$400 million is the authorization with 65% being allocated for Elementary, Secondary and Vocational Education. This would mean a total of $260 million for this area. 260 million dollars is simply not enough to help 16,000 school districts improve their instruction of math, science, computer technology, vocational education and foreign language as well as develop an adequate pool of qualified teachers. Spread evenly across the country $260 million would amount to about $5.00 per student, certainly not enough to sustain a broad national effort. We believe it to be seriously underfunded.

Another concern is the 50-50 matching provision. With limited resources available, together with the previously mentioned expenditure limitations, in many states and school districts it may be extremely difficult to raise the matching requirement. It may result in the affluent districts getting the funds. The districts unable to obtain matching funds, who are usually the ones with the most need, unable to benefit from this Act.

Our parent organization, AASA, feel that Congress could help us a great deal by directing the National Institute of Education, NIE, to conduct a series of studies on the math and science area so we can develop our information base but AASA suggests that such NIE studies be funded from the regular NIE appropriation and not from S530 or similar legislation. NIE should provide information to determine where teacher shortages are and how severe they are. The impression of AASA is that the shortage of qualified teachers is not evenly distributed. NIE scholars should also work with industry and the Pentagon to identify the skills required for future workers and military personnel and what porportion of the population will need those skills, so that we will not waste resources teaching students the wrong skills. Also, NIE should help develop our knowledge base about computers, because the computer seems to be driving the revolution in math and science. For example, we should determine how to use computers best as an instructional tool and for which students. Millions of dollars are being invested in computers when all the experts agree that we do not know how to use computers best for all students and for all courses. Computers are a fact of life but the manufacturers have not invested much in educational software courseware cause they are not sure of a return on their investment.

If schools are to select the right machines and coursework to meet student needs the answer to tough questions will have to be developed.

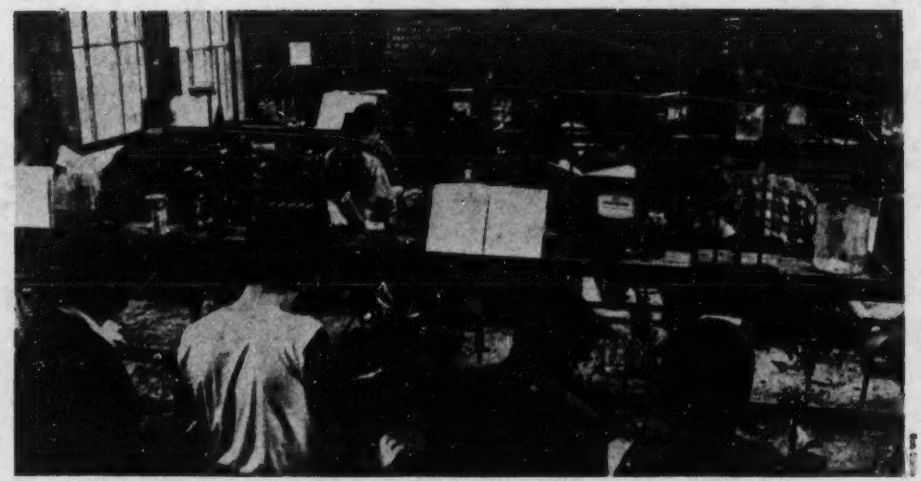
It is also observed that S530 provides little or no funds for the administration and evaluation by the State Departments of Education. Again with limited resources available at the State level some funds should be made available for these purposes.

We also have a concern relative to the distribution of funds by the State Agency. We understand (A) distribution in the number of children in the district but are concerned with the provision (B) the size of the proposed program in terms of the number of students to be served and the number of grade levels involved in the program.

The regulations that may result for the implementation of this Act are also a concern. So often regulations deter the effectiveness of the intent of the Act. We hope that does not occur.

While not a Federal responsibility, we urge the States reexamine teacher certification requirements so as to better utilize persons in our industries with technological expertise.

We thank you for the opportunity to appear before you today and again express to you our sincere appreciation for your continued efforts to enhance the educational opportunities for our society.



Even students at top-notch schools such as Manhattan's Stuyvesant High School must make do with out-of-date equipment.

LOW-TECH EDUCATION THREATENS THE HIGH-TECH FUTURE

The U. S. must act to reverse the slide into technological illiteracy

American science education is in miserable shape. So miserable, in fact, that its failings threaten to undermine both domestic employment and the nation's economic standing in the world. A steady supply of engineers and scientists is critical if high technology is to play a larger role in the U. S. industrial base. Americans will also need an unprecedented understanding of science if they are to live, work, and vote in a world that is increasingly dependent on science.

The quality of scientific and technical education in the U. S. has been slipping since the brief surge of attention in the decade that followed the 1957 launch of Sputnik. During the politically volatile boom years of the late 1960s, schools shifted their focus from achievement to social relevance, and federal funding for science education waned. The public programs of the 1970s drained school coffers further, while property-tax revolts in many states whittled their traditional financial base to almost nothing. "Our mistake was in thinking it was all over the day we got to the moon," says F. James Rutherford, chief education officer at the American Association for the Advancement of Science (AAAS).

Today, only 6% of U. S. college students are enrolled in engineering programs, compared with 21% in Japan. And for every hour that an American child spends in school, a Soviet or Japanese child spends two and one-third hours. Warns Education Secretary Terrel H. Bell: "If we don't do more to strengthen our education program and have a more rigorous and demanding curriculum, we're going to start losing out to competitors abroad who are making that commitment."

Years of indifference

Not only will high school graduating classes drop to half their present size by 1990, but also far fewer of the graduates will have taken science courses. Less than one-third of U. S. high schools now require enough math and science courses to qualify their students for entry into an engineering college. And scores on college entrance exams in math and science have declined steadily for 20 years. "The projections are awful; I'm scared to death about the [small] number of technical people that are going to be available," says Thomas A. Vanderslice, president of GTE Corp.

Leaders throughout industry, education, and government fear the U. S. will continue to feel the punishing effects of years of indifference if sweeping changes are not made in the education system. Their concern is prompting a reexamination of that system, from the elementary schools to the universities.

Everyone is looking for curriculums that teach students not only the computational skills of science and math but also the reasoning skills on which they are based. Few students now receive such schooling. As a result, "the American general public is technologically illiterate," says Michael I. Yarymovych, Rockwell International Corp.'s vice-president for advanced systems development.

To combat that dangerous technological illiteracy, educators are stressing the need for all students to be given a general knowledge of science. "We need to provide nonscientific, nontechnical people with some understanding of science and technology," says David S. Saxon, president of the University of California. "Science is really a part of the liberal arts, and we ought to be educating people more broadly in this context."

Technological illiteracy and professional shortages have their roots in the earliest school grades. "Some 20 or 30 years ago there was a great glamour attached to going into the sciences, a feeling that you were working for a greater cause, the national good," says John K. Hulm, director of research and development planning at Westinghouse Electric Corp. Now that attitude has faded, and "children in public school systems are not taking math and science classes," says Bernard H. List, vice-president for training and education at Texas Instruments Inc.

A critical shortage of qualified instructors is not helping either. Fully 50% of the teachers hired in 1981 to teach science and math were uncertified in these subjects. In the past decade alone, the number of math teachers in public schools dropped 77%, and the number of science teachers fell 65%. In addition, 25% of the teachers still in the classroom say they plan to leave.

Money, lack of prestige, and difficult working conditions are largely responsible for the teacher shortage. The average salary for a beginning high school science teacher is $12,000, which pales beside the $20,000 starting salary that a science or math graduate can earn in industry. "It's tough," says Sandra Feldman, vice-president of the American Federation of Teachers (AFT). "There are a lot of people who would otherwise be interested in teaching who feel, 'Why should I go into something where I'm never going to get rich and where I'm also going to be looked down upon?' "

But upgrading salaries and increasing the number of teachers will not happen without a struggle. Proposals to allow scientists without teaching credentials to teach full-time in secondary schools are already under fire, as are plans to give math and science teachers salary bonuses. "We don't think you should pay a differential just because this is a shortage area," says the AFT's Feldman.

Federal programs are needed to stem the exodus of teachers from the classroom and to fund retraining of those who stay, most observers feel. But they worry that the amount of money proposed is little more than first aid. "The investment has got to be of an order that is appropriate to the mass of the problem," says the AAAS's Rutherford.

The furthest-reaching changes must be accomplished at the grass-roots level. One task that many people feel is most appropriately handled by the state and local school boards is updating science and math curriculums, which rarely include the study of modern technology in their course offerings. Other jobs for local groups include the upgrading of teacher qualifications, hiring practices, and graduation standards.

Several innovative grass-roots efforts are already under way. And industry is digging into its pockets to come up with financial aid and help for local school districts in modernizing their science offerings. In North Carolina, grants and gifts from private corporations are supporting the North Carolina School for Science & Mathematics, a residential high school for gifted students throughout the state. And Standard Oil Co. of Ohio recently gave $1.67 million for a national junior high school science education project, to be directed by the AAAS. "To turn the situation around, we must invest in the science and mathematics education of our young people," says Alton W. Whitehouse Jr., chief executive officer of Sohio.

At the elementary school level, a number of companies are developing programs patterned after a successful model developed in Houston. Such companies as Bechtel, Shell Oil, and IBM have each "adopted" a local school and sent their technical staff to work with students. Engineers from M. W. Kellogg Co. are teaching students how mathematical theories apply to practical problems in engineering. And in Dallas, Texas Instruments is working with the Dallas Independent School District to organize a program that has technical staff from the company teaching math to fourth- and fifth-graders.

More companies are now donating computers to schools.

Science in action

Industry is helping to promote computer literacy as well. TI has lent Houston schools 24 interactive computers that low-income parents may borrow to use with their children at home. "If we don't do something about computer literacy, we will have another kind of haves and have-nots in our society that will be much worse than the black-white division," warns TI's List.

A lack of up-to-date equipment is also hampering science teaching in the nation's schools. Even such highly regarded schools as Manhattan's Stuyvesant High School have had to make do with antiquated equipment. Growing numbers of companies are donating computers and technical equipment to schools that otherwise could not afford them. "Operating something, interacting with something, is essential to technological literacy," comments Edward E. David Jr., president of Exxon Research & Engineering Co. "We have got to develop skills for involvement, not just skills for employment."

While these corporate programs provide direct teaching assistance and badly needed modern equipment, many participating companies feel their main contribution is simply to expose young people to science in action. Scientific-Atlanta Inc., a Georgia satellite-communications equipment maker, brings students from an Atlanta engineering high school to its labs to observe work in progress. "We try to give them some sense of the type of training a person needs to become an engineer," says Jesus Leon, program coordinator. "By providing role models, we can make it easier for them to decide to become engineers."

Despite the increasing pace of such efforts, most observers feel it will take at least a decade before American education catches up with the rest of the technological world. "Education is like a supertanker. It takes a long time to stop and turn around," says James O. Roberson, who heads the Maryland Economic & Community Development Dept.

Emphasizing science at the expense of the nonscientific disciplines is wrongheaded, warn many educators. "High technology is going to require all kinds of people, not just people who know math and science," says Feldman of the AFT. "People are going to need a good solid basic education, which means English and the ability to think critically."

These educators worry, too, that Congress will be lured into taking a "quick-fix" approach like that of the Sputnik era. "Sputnik backfired," says Frank Press, president of the National Academy of Sciences. "We weren't consistent, funding wasn't stable, and we lost a lot [of momentum]."

Now, however, everyone agrees that a sustained approach is needed to rejuvenate education and establish a long-term base of literacy. Many see the current flood of attention as a sign of hope. "A great deal more is needed," says Exxon's David. "But the most encouraging sign I see is that people have begun to relate the kind of education we have to the economic health of this country." ■

Senator PELL. Thank you very much, Mr. Froberg. Now, we come to Mr. Eddie McElroy, who is an old friend and wears two hats, both as president of the AFT, and also president of the AFL-CIO. And he is here with his hat as president of the AFT.

Mr. MCELROY. Good morning, Senator. I want to try to accomplish the task of just wearing one hat. As you know, the Rhode Island Federation of Teachers is the State affiliate of the American Federation of Teachers. And as an aside, you have had a statement from our national president, Albert Shanker, which was delivered to your subcommittee on March 9. And as a State affiliate, we subscribe fully to the statement that President Shanker made in that appearance.

We represent over 7,000 elementary and secondary schoolteachers, school paraprofessionals, health care professionals, college professors, and State education employees. And we appreciate again the opportunity to appear before you and the opportunity you have given us to express our opinion on what we think is a very vital issue.

Rhode Island, at present, is deeply involved in a study of its economy, as you know, the so-called Murray Commission. The ultimate purpose of the study is to properly plan for and encourage economic development within the State.

The hoped for result is an expansion of the State's economic base and the provision of quality employment opportunities for our people. We believe that this hoped for outcome will be possible only with a strong educational program being in place for the people in this State. The current national attention and interest in math and science education is very welcome, and we believe long overdue.

As a nation we have come to the conclusion that our economic welfare and our competitive position in the world economy is inextricably interwoven with our ability to properly educate our people. Specifically, our current ability to compete in the world market is being challenged by others who are giving more emphasis to quality math and science education.

As an aside, I might say that some of the difficulties that we face in the State in terms of our competition with other States within this country are also, we see, primarily affected by the amount of education and the educational opportunities that are available.

The Rhode Island Federation of Teachers believes that S. 530, which would provide for a program of financial assistance to States in order to strengthen instruction in mathematics and science, as well as other areas, is an important step in a platform for discussion of this very vital issue.

In view of the dimension of the problem we are faced with, the $400 million which is authorized to be appropriated by this legislation is an extremely limited amount of money. And I, too, hope to address this to President Reagan. I would like to address it in the elections of 1984. I think that would be the most dramatic way to do it, Senator.

As a result of the limitations of available money and the economic and political realities which we face, we respectfully make the following suggestions for modification to the legislation. And I only have four of them, Senator, and I think that you have probably heard from some of us about these.

Since the dollars are limited, we suggest that the bulk of the available money should go to the areas of greatest need, and we think that the present title I formula works very well in this regard. And we therefore suggest that money should be apportioned, 50 percent on the basis of the average daily attendance and 50 percent on the basis of the title I formula. It seems to us that that would give us the best of both worlds, that we target the moneys, however, at the point of what we think should be priority and need.

Second, we think the major emphasis of this program should be in the elementary and junior high school areas. We think that instruction in the elementary schools by science specialists is an important first step in improving the quality of science instruction. It seems to us that too often when we talk about mathematics and science instruction, we are talking about it as a precollege instructional program. And we think that the time to capture the attention and the minds of the children is at a very early age. If properly done with proper instruction, I think we can generate the kind of interest that is necessary in order to have students show that interest by specializing in those fields or seeking further education in those fields later on.

Third, since the dollars are limited and since vocational education reauthorization is due later this year, we think that it is better to place the available dollars in this legislation to the nonvocational school area, and that moneys for the vocational education sector could be specifically dealt with when the vocational education reauthorization bill comes up in the Senate and the House.

Finally, we think the legislation should target significant amounts of money to the training and retraining of teachers. Retraining should be available to teachers facing layoffs as well as teachers who are inservice. In addition, special measures should be aimed at elementary schoolteachers to upgrade their math and science skills.

Let me conclude, Senator, that in these brief remarks to thank you specifically for not only giving us the opportunity to speak, but also thanking you for taking the lead as you have done in your long career in the U.S. Senate, taking the lead on what we think is a very vital issue. We appreciate the opportunity of you coming to Rhode Island to give your people back home an opportunity to express themselves in this bill.

Thank you very much.

Senator PELL. Thank you very much indeed, Mr. McElroy. And now we come to Mr. Coleman, representing NEA and he is here, and also I see in the audience your predecessor, Mr. Kapstein. I look forward to having as good relations with you as I had with Mr. Kapstein, although maybe they will not extend over the same period of time. We have been working for 22 years together.

Mr. COLEMAN. Thank you, Senator. I am sure our relationship will be very compatible.

My name is Herman Coleman. I am the executive director of the National Education Association in Rhode Island. I speak to you today on behalf of 7,000 Rhode Island teachers, faculty, aids, secretaries, custodians, technicians, and other educational personnel, as well as 1.7 million individuals nationwide who are the National Education Association.

I am particularly delighted to present testimony on this subject, having been trained in both math and science myself, and having had the opportunity over the last 15 years or so to observe the tremendous decline in the allocation of resources and direction for science and math education in this country.

We are in the middle of a revolution, a technological and scientific revolution that is comparable to no other time in our country's history. It is the era of the machine, the computer. Its presence is felt not only in business and technology, technological settings, but in our homes, our schools, cars, offices, banks, supermarkets, and entertainment centers.

Our children are among the most versed in the tools of this changing world, as they should be. They seem to acquire skills and knowledge overnight, always informed on the latest computer games, never afraid to push the buttons or turn the dials that make the screens come alive or cause their toys to talk to them.

But are these children receiving enough formal education in disciplines that help them transfer these skills and interests to productive careers in math, science, research, engineering, or computer technology? The research shows that the United States has fallen dismally behind in its responsibility to provide a comprehensive education to our youth in these areas.

Years of skimping and scraping for funds for public education has resulted in a plethora of young people ill prepared to face the economic and technologic changes before us. A large part of this problem stems from a national shortage of math and science teachers. Industry, with attractive salary packages and the chance for career advancement, has attracted many talented individuals from our classrooms and colleges.

Coupled with the exodus of qualified teachers—coupled with the exodus of qualified science teachers is the lack of math and science courses available in elementary and secondary education. Fewer students are taking fewer courses and spending fewer hours studying math and science.

What is this a product of? We do not know for certain. It could be that the Federal Government initiated the trend by decreasing funds for research and development during the last two decades.

It could be the result of the Government's withdrawal of support for teacher training institutes and curriculum development. Even the National Science Foundation has deemphasized science education, although the general funds have increased dramatically.

What has caused this crisis is not important. Solving it is critical to the health of our Nation. We in education are heartened to see a recognition of this national problem. We are pleased to take our part in seeing to it that it gets solved in the most beneficial manner.

According, we have spent some time studying all math and science legislation currently before the 98th Congress. The administration's proposal to allocate $50 million of bloc grant funds to train individuals to teach math or science at the secondary level falls far short of the ideal solution to this problem. It ignores the need for better science and math instruction at the elementary school level and provides no tools for planning and implementation of a comprehensive program that would make all of education responsive to the total problem.

Several bills introduced seek differential pay for teachers in these subjects. We are opposed to emphasizing one portion of an entire curriculum at the expense of all others. Reading and writing are no less important than math and science and require no less training or skill.

In contrast, S. 530, the subject of this hearing, is a far better approach to the crisis. It includes additional subject areas, emphasizes all levels of curriculum, including higher education, and provides more funds to accomplish this task.

We feel, however, there is a need for a long range plan. A more comprehensive solution can be found in the American Defense Education Act. ADEA not only meets the urgent needs for improving instruction in math, science, communications skills, foreign language, guidance, and counseling, but also focuses on long-range technological issues essential to our national security.

It provides a planned program—processional program to clearly define goals and evaluation systems designed specifically for individual school districts. ADEA meets a comprehensive list of criteria developed by our country's educators.

I have attached to my testimony a brief summary of the major points of ADEA. And I really appreciate you sending an invitation to our organization to present testimony before this important hearing.

Thank you, Senator.

[Material referred to follows:]

CRITERIA FOR ASSESSING MATH/SCIENCE EDUCATION PROPOSALS

- The proposal should be sufficiently comprehensive to include improvement of the quality of instruction in the fields of math, science, communication skills, foreign language, new technologies, guidance, and counseling.

- The proposal should provide for the planning and implementation of programs at the local level.

- The proposal should provide for local evaluation of the progress of program developed by funds from the proposal which requires participation and input from the school board, parents, teachers, appropriate bargaining agents, business, industry, and community.

- The proposal should establish participation requirements for local school districts which voluntarily participate in the program.

- The proposal should not advocate differential pay for any subject matter area.

- The proposal must provide for administration under the Department of Education.

- The proposal must provide for sex equity and equal access to programs.

- The proposal must provide for a research component to provide for improvement in teacher training methods, utilization of equipment, and classroom delivery methods and systems.

- The proposal must provide funds for the higher education community to jointly participate with local education agencies in preparation of the necessary number of qualified teachers to meet the need.

- The proposal's federal dollars for the programs must be directed to the local education agency for program delivery.

- The proposal's funding authorization level must be of sufficient quantity to provide a reasonable expectation of success on a national level.

- The proposal should require that the current level of expenditure for educational programs should not be reduced as a result of funding for the new program.

Senator **Pell**. I thank all of you very much indeed for being here. There are about 10 different bills in the Senate alone, not counting the House, focusing on this problem. The Hart bill, the ADEA, which Mr. Coleman mentioned, calls for an expenditure of $2.2 billion, I believe; obviously, I would like to see the expenditures be more than the $400 million that is in our bill.

But the bill that Senator Stafford and I have worked together on is basically what we see as being possible of passage. As you know, a $2.2 billion bill has not the tiniest chance of passage in the Congress at this time with the administration as it is.

Perhaps what we should do is make our bill $400 million, have the sum spelled out for this coming year, and then open ended for the future years when there might be a different administration. This is one of the thoughts that is going through our minds. But what we have to work with in politics is the art of the possible, and this is what we are seeking to focus on.

In connection with the formula of distribution, Ms. Kenyon, I know, feels it should be done just on the basis of population. Mr. McElroy feels that you should crank into it the very successful title I formula where you try to find need. I am just interested if you had any reaction to Mr. McElroy's statement, Ms. Kenyon?

Ms. **Kenyon**. Well, I do, Senator, because I see the need absolutely across the spectrum—I see it in both title I schools and the need just as severe to upgrade—particularly on the elementary level, to upgrade science and math in all the other schools.

Senator **Pell**. I think this is one of those conundrums that we are going to have to work with and hope to come out with something reasonably fair.

In connection with the stipends for teachers that you mentioned, that is included in the Dodd bill, which I am a cosponsor of, and we hope to crank in, the elements of that into this bill. Senator Dodd is a member of the committee and the subcommittee, and for that reason, we hope to blend them before we are through. But I agree with your point and we will do our best in that regard.

When it comes to matching funds, Ms. Kenyon, you mentioned that and others have mentioned that. The present formula is 50–50. Many States have some objections to that, even though the 50 percent for the local share would be in kind. And again this may be changed to a 60–40 or 75–25. I am not yet sure. And again, there are so many questions of this sort you have to handle it kind of delicately to see what formula will go through and what formula will either avoid a Presidential veto, or if there is a veto, we will have enough support behind to overcome it.

While for political effect you can introduce a bill, I think that is a little dishonest unless you really think there is an opportunity of trying to get it through and passed in the end.

Sister Andre, in connection with the points you raised, I think section 7(f) of the bill answers some of the points with regard to being able to provide help, provisions for help to local nonpublic schools.

I would agree, too, with what was said earlier, that $260 million for the teacher training and retraining is simply not enough. But this is a lot more than the administration bill, which is $50 million. You may remember that the President in the state of the Union message talked about the need, but then to resolve it, he is going to put on the bandaid of only $50 million.

Maybe our bill is just a huge bandaid, but at least it is a bigger bandaid. And it would move us down the road in this regard.

As far as support goes for the bill, I would say some kind of approach, some kind of legislation along this line will pass the Congress. It is really a question of how much and timing, I would say. And actually also I am reminded here that our bill has already 20 cosponsors which gives it a certain force and substance, meaning it will probably be the vehicle upon which the others, hopefully, will ride. And when I say, "our bill," I mean Senator Stafford's and my bill, S. 530.

Now, there is one question I would be interested in any comments from any of you: Do you think we should focus more on the high school level or more on the elementary and general school level? And I realize some of you have touched on this, but I would be interested in any further comments that any of you might have.

Ms. Kenyon first.

Ms. KENYON. Senator, I see the need at the elementary level for a new curriculum and new inservice training of teachers, but at the secondary level, I see a severe need to upgrade our lab equipment.

Mr. COLEMAN. Well, I feel the same way. I am very hardpressed to say where the moneys ought to go. I think that a lot of emphasis needs to be placed on long-range planning. You see, we have floated in and out of support for a number of education programs, particularly science and math. But there has been little continuity. If I look at the issue from a continuity point of view, long term needs, I may imply that the greatest emphasis ought to be in the elementary level.

But what about the large number of people at the secondary level right now who have a tremendous need? I think somehow we have to address both needs, but a lot of focus has to be on a long-term plan that is going to address the kinds of skill needs that our young people are going to have in the next century.

Senator PELL. Thank you. I think Sister Andre wanted to say something there. Could you pass her the mike?

Sister ANDRE. I would just like to make a comment that I think right at this moment, from my perspective, anyway, it would seem that the elementary level is the place to put our best efforts because it is at that level that enthusiasm is developed for future planning.

And I think that if we can develop enthusiasm for the areas of math and science by retraining teachers and helping them in their efforts to upgrade themselves, I think this would be a very positive place to put our efforts.

Senator PELL. As I mentioned earlier, Alexander Pope's old couplet, "As the twig is bent, the tree doth grow." And I think there is a great deal in that.

Mr. MCELROY. Senator, I think we would contend that all students should get more math and science, and I think that now we have to determine whether we are going for the quick fix or we are going for the long term, long pull in terms of overall educational excellence.

Therefore, I do not have a problem; I agree with Sister Andre; I think we should put our emphasis, our major emphasis in an area that is almost totally left out of the national debate on this issue, and that is the elementary and the junior high grades.

You know, John Dewey said that one of the most important things we have to do in terms of educating children is to deal with the scientific habits of mind. And so we are not interested—I am not interested in a vocational program that really says that we are going to—the interest and the focus of national legislation should be only on educating future mathematicians and scientists.

Our position should be that all children at all levels of education should have an opportunity to deal with the scientific and the mathematical ability that is necessary to compete in the world, regardless of the vocation chosen. And so for that reason I think we want to focus our attention on the earlier grades.

There have been studies, Senator—and I do not have them with me but I am certain that we could share them with you; you probably have them already—that show that in the very early grades, there is tremendous interest, especially in the fourth and eighth grades—there is a tremendous interest among kids in science and mathematics. And that interest drops off by the time the children are in the 10th and the 11th grades.

Now, if seems to me that if we can do something to focus our attention on some of the research, for example, why is the student so interested in the fourth grade, and let us take some of that research to show us why he is so interested and then capitalize on it so that we can hold their interest through the high school and through the period of time they are picking their vocation.

So I would hope that through all of this national debate that we would be able to focus some attention and a great deal of attention on the elementary and the junior high area and ages.

Senator Pell. I think that——

Mr. Gainey. Yes, Senator, I wanted to concur with what everyone has said. I think, though, we have to look at this issue from two perspectives, the long range and the short range. The long range, certainly, we have to develop programs and instruction that begin with the elementary and continue through junior high and senior high.

However, the reality of the situation is today we need the preparation for the students who are going to be exiting the secondary level into the postsecondary level. So I think we are looking at it from two perspectives. I do not think we can look at the Band-Aid approach and tuck it away, but we have to look down the road.

Senator Pell. In connection with that downward course in math, I always sort of wondered if one of the reasons might not be the fact that we went for the new math in the seventies and then left the new math and went back to the old math. Am I right in this worry? I would like to ask any of you who are professional teachers your view on this.

Mr. Gainey. All right. I would like to respond to that. I think it was an infusion that did not carry with it a lot of the emphasis that we place here. We had existing teachers who were handed a new approach to a problem they had been dealing with for years without the proper type of inservice.

And in terms of the new technologies of today, I think that we have to constantly upgrade the professional staff in the application of these new technologies.

Senator PELL. My question is a little different, and maybe I am wrong. First tell me if I am wrong. My belief is that we went to the new math with the children of the seventies, and then after 10 years of it found out that it really was not much good and we have gone back to teaching the old math.

Is that correct?

Mr. GAINEY. Maybe my response was not clear. I do not know exactly what the research says in this area, but my feeling on it is the fact that we gave teachers on board a new vehicle to deliver and we did not properly give them the inservice training in the modern math. I am talking about people on board.

Senator PELL. Excuse me. That was not my question. My question——

Mr. MCELROY. The answer is yes, we have gone back to——

Senator PELL. Yes. All right. We have gone back. Then, if that is so, might not that account in part for the deterioration in math because of this 10 year hiatus as we were fooling around with another kind of math?

Mr. MCELROY. I am going to plead ignorant; I was a social studies teacher. [Laughter.]

Mr. COLEMAN. Well, I think that that answer is partially correct. But I think the greatest problem rests with the fact that we have not had any meaningful long range planning in our schools for too long. Now, somehow modern math became an instant solution to a very serious problem, and we focused on modern math as the vehicle to do that without ever coming to grips with what it really meant.

What do we really want to accomplish through this so-called modern math? We have found that it was not a panacea. Now we are moving back to more traditional approaches to teaching math. And we find ourselves 20 or 30 years behind in terms of skill development on the parts of the practitioners and the kinds of skills that young people are leaving as they enter the world of work.

But I think the fundamental problem is being—having blinders on and not doing an adequate job of educational planning.

Senator PELL. Good. I thank you. And I would thank all of you for taking the time to come here and wish you well and look forward to receiving your suggestions. And as I said, any one of them that is specific in nature, we will go over and then we will have to reach a judgment determination as to what is most likely to fly, to pass.

I wish you all well, and thank you for being with us today.

Now, we have, I see, that President Newman and President Sweet of the University of Rhode Island and Rhode Island College, respectively, are here with us. And maybe they would come forward for a few moments.

I thank both of you for being here. I apologize for having started ahead as we did, but we had no choice because we have votes coming up this afternoon on the social security legislation, and I have to leave in about 10 minutes. Any statements that are full length will be inserted in the record as if read.

STATEMENTS OF DAVID SWEET, PRESIDENT, RHODE ISLAND COLLEGE; AND FRANK NEWMAN, PRESIDENT, UNIVERSITY OF RHODE ISLAND

Mr. SWEET. Thank you, Senator, and thank you for your constant support of education at all levels, and particularly in my case, for higher education.

I am David Sweet, president of Rhode Island College, and I do want to thank you for the opportunity to speak about S. 530. Let me tell you that the educational professionals at the college inform me that given the current curriculum in most secondary schools, the critical problem, at least here in the Northeast in relation to math, science, technology, and foreign languages instruction in the school is more one of quality rather than one of quantity.

That is to say, from contacts between our education faculty and school administrators in the region, we have concluded that there are enough teachers in these fields to serve the numbers of students currently enrolled in these crucial fields.

We know, however, that if the secondary school curriculum is changed to require more students to take more math, more science, more foreign languages, then there will be a shortage of teachers in these fields, and that we recognize too that among the problems being addressed by this legislation is the need to increase the number of people who have received education in math, science, foreign language, and technology.

Our second major concern, however, relates to the quality of instruction in the schools in these critical areas, and it is that that I wish to address. As the subcommittee is no doubt aware, a key to the quality of instruction offered in these fields—and in all other fields, particularly at the secondary level—is the amount and the quality of academic discipline based instruction that the teachers in these subjects have received from the institutions of higher education.

This in turn is too often a function of State certification requirements. It is not simply a function of State certification—of the graduation requirements imposed by institutions which prepare teachers.

At Rhode Island College, for example, a student cannot receive a degree in a teacher education program unless she or he has completed an academic discipline based major. But to become certified to teach in a subject here in Rhode Island, an individual at present need complete only 18 hours of college level instruction in that subject.

This means any 18 hours, not even 18 upper division hours of instruction. All the person needs to do to be certified is to take 18 hours of essentially introductory courses. These courses may even be taken at different institutions and not be part of any coherent program.

It is unrealistic to expect that every secondary schoolteachers in one of these crucial areas will have completed an academic major in college before she or he is permitted to instruct in the subject in high school. But it is my conviction that the proposed legislation does offer an opportunity to address the problem of teachers with inadequate preparation to teach in these crucial subjects.

Specially, I would urge the subcommittee to incorporate into the legislation provisions which would make the funds to be appropriated under the legislation available only to States which require that a teacher complete a coherent 24 semester hours of work in the subject taught in a certificate program which has been approved and is offered by the faculties in the respective disciplines in the institutions of higher education having teacher education programs in each State.

In my judgment, some such provision as this is essential if the Nation is to deal meaningfully with the problem of instruction in the critical subjects covered by this proposed legislation being offered by teachers who are not adequately prepared to teach in these subjects.

The funds available under legislation can be used to assist these teachers obtain the required upgrading. But it is very important that the legislation require that such upgrading occur in order for a State to be qualified to receive the funds.

In particular, it is not merely enough to offer teachers the opportunity to receive additional preparation if they choose to take it; all too often only those least in need of additional preparation come forward voluntarily. It is important that all teachers be required to have at least this minimum level of preparation.

And, moreover, it is also desirable that provision be made to require that teachers continually upgrade their preparation, given the rapidity with which new knowledge emerges in all disciplines, but particularly in the disciplines covered by this legislation.

Thank you, Senator.

Senator **Pell**. Thank you very much indeed, President Sweet.

President Newman?

Mr. **Newman**. Senator Pell, I thank you for the opportunity to come, and I recognize your time limits.

Since the people ahead of me have had the opportunity to comment at length on elementary and secondary concerns, I would like to just, in the short time that is available, talk only about the impact of your legislation and the legislation that others have introduced in the Senate on universities themselves. And as I understand, there is some possibility that many of these may be put together in some sort of an omnibus bill.

And let me just very quickly comment on just a few points. We have just recently put a report together for our board and I have included in the testimony a copy of that report.

[Note: In the interests of economy the report referred to was retained in the files of the committee.]

[The prepared statement of Mr. Newman follows:]

STATEMENT OF FRANK NEWMAN, PRESIDENT, UNIVERSITY OF RHODE ISLAND

I appreciate the opportunity to testify with regard to the "Education for Economic Security Act." It is an important bill. It is hard, in fact, to overestimate its importance in light of two concerns of our times.

One is that, as is now suddenly apparent to the national consciousness, it makes no sense to turn our collective backs on the educational system of the country when it is so clear that a sound educational system is central to economic growth. The other is that it would be foolish to assume that the only answer is the status quo, that every program of the past is appropriate for the future.

There is a new, insistent demand for improvement in education, both elementary and secondary and higher education. The driving force is the recognition that in the current world, our economic growth and prosperity is dependent on the new knowledge and well-educated graduates that are the products of a first class educational system. There are other powerful reasons to be concerned about quality in education, not the least of which is the essentiality of education to the functioning of a free society. But it is because of our current deep-seated concern for the economy - for new jobs, for our ability to compete internationally, for a growth in the GNP and consequently in tax revenues - that the people of this country are now awake to the urgency of the support of education.

As I know that others of my colleagues plan to speak at length about the impact of the bill on elementary and secondary education, I will concentrate on the problems facing universities and what steps will help them perform better. I do not mean to imply that these two parts of the education system can be considered as separate. There are intimate linkages between higher education and elementary and secondary education. Neither can be effective if the other is not. I understand as well, that many of the other proposals now before the Congress that deal with this subject may likely be included in this bill, so I have taken the liberty of addressing the subject somewhat more broadly.

At the University of Rhode Island, we have recently, at the request of the Board of Governors, examined these issues in some depth. The resulting report is entitled The Edge of Excellence. The description it contains of the changes going on in the economy of Rhode Island and New England provide further background for the trends you have described in the bill and in your statements. I have included a copy with my testimony and will not repeat the information it provides. I would appreciate the opportunity to comment on a few of the conclusions.

First - if one studies the interaction between universities and economic development, it is quickly apparent that the parameter that is critical is quality. It is not enough to mount programs in computer science or pharmacology, or to build buildings or enroll more students in engineering or chemistry. What apparently matters is the sheer quality of the university - how well educated are its graduates, how skilled its researchers in creating breakthroughs, how willing and effective its faculty in outreach to the other segments of education and to industry. To quote The Edge of Excellence, "the difference between academic programs that are reasonably good and those that are truly first-rate is hard to measure, but very real."

The issue, therefore, is how to improve the quality of the University - not narrowly, not just the technical programs - but the fundamental quality of the University. It would be easier if it were only a matter of the Computer Science Department, but it is not.

Second - the universities must continue to change and at an accelerating rate. In many ways, universities are timeless, the custodians for society of the past. But in other ways, they must be dynamic. The report cites a series of the profound and pervasive changes that are transforming the University - new disciplines, new equipment, new ideas even in old disciplines.

Central, therefore, to any programs of support is that they must not only help to improve quality, but help to encourage change where it is needed. Again, this is not an easy task.

Third - in every aspect of our efforts, we must encourage the entrepreneurial spirit. Our graduates must be encouraged to develop the capacity and willingness to take risk, or there will be too few new start-ups, which economists and policymakers now belatedly recognize as the key factor in both technological advantage and new job formation.

But the entrepreneurial spirit is central to the success of the university as well. Our faculty, as researchers and as teachers, must be encouraged and aided in reaching out to new ideas. The trend of the times, with shrinking budgets and declining enrollments, is just the opposite. It is to pull in and to conserve, to wait things out. Nothing could be more dangerous to the results you seek than a timidness of spirit.

The form of assistance, therefore, must be such as to encourage the entrepreneurial spirit within the higher education community and in its graduates.

With these three conclusions as background, I would like to make the following suggestions:

1. While not a part of this bill, the adequate funding of the Pell grants authorized in 1972 are central to the purposes spelled out in this bill. Advances in the economy, particularly

those based on technological breakthroughs, depend on openness - openness to ideas, openness to new people. We need to insure there is a continuing diversity of higher education institutions and that all sorts of students, particularly those motivated to move themselves ahead and take the risks I have described above, have the chance to attend college.

In addition, in a society that is increasingly sophisticated in its use of advanced technology, we are in danger of slipping into a permanent two-class society - those with access to college and good jobs and those confined to menial jobs. The antidote to both is the assurance of appropriate and enough student aid.

2. In certain fields, there must be new federal support of graduate students. There is a well-documented shortage of faculty and of industrial researchers with advanced degrees in such fields as engineering, computer science, mathematics, physics, or chemistry. In these fields, graduate enrollments have been declining as the job prospects of bachelor's holders has improved. A decade ago, OMB cut back on graduate fellowships because the supply and demand had reached a balance. Today, in these fields, there is a dangerous imbalance.
3. There are two critical areas where specific resources are needed - laboratory equipment and library materials. In both cases, the cost of the rapidly evolving materials is rising sharply, yet budgets in constant dollars are shrinking. These are areas in which the universities cannot lag behind but must be leaders.

4. The administration recently proposed a program of research support targeted at new, young investigators. This is a sound idea. We must insure that there is a steady flow of new investigators into university research to prevent stultification and to challenge existing ideas.
5. The quality and imagination of teaching and research must be the central concern. The form that assistance takes matters. One of the most successful federal programs in improving the quality and excitement of colleges and universities and in helping to accelerate constructive change is the Fund for the Improvement of Post-Secondary Education, also a product of the 1972 legislation. I believe that this form of competitive grant distribution of funds could be used to achieve the aims of the bill as spelled out for higher education - with maximum efficiency and maximum impact. In fact, its consideration for the bill's purposes in the distribution of funding for elementary and secondary education might well be sensible.

I appreciate the chance to come today and the chance to be heard.

Mr. **Newman**. And we have tried to look at the very questions you are talking about as they impact on the university.

Let me draw just three conclusions out of that report. First, if one studies the interaction between the universities and economic growth and universities and their impact on elementary and secondary education, the thing that is quickly learned is that the important parameter is quality. The tendency is to think that the important parameter is technological skill. But it is not.

If one looks across the country into places where the university has successfully interacted both in economic development and in elementary and secondary, over and over again you come to one conclusion: The quality, the basic quality of the university is critical.

So it seems to me, the crucial issue is how to improve the quality of the institutions. And that is difficult. It would be easier if it were to improve simply the technical skills of the institutions.

The second point that comes to the fore is that we think of universities as relatively timeless, but in fact they are undergoing terrific change, and if anything, to meet the requirements that we are talking about here today and the things that are talked about in terms of economics, there is going to have to be a more rapid rate of change within the universities themselves.

Therefore, any program ought to have that as it impacts on institutions of higher education—it ought to have that as one of its goals, the capacity to bring constructive change.

And the third conclusion I wanted to mention from that report is that a great deal of the attention now is focused on entrepreneurial efforts. A great deal of interest is in the formation of small concerns. When we look at ourselves, we ought to be asking two questions. Are we graduating young men and women who are capable of being entrepreneurs, are willing to take risks? In addition to the math-science questions, are we in fact encouraging their capacity to go out and take the kind of risks that we are all talking about in society.

And also, do we recognize that we as institutions have to be entrepreneurial. It is not enough that we should be of high quality; we have to be entrepreneurial. We have to be seeking out.

So the form of whatever assistance that comes ought to encourage our own risk taking within the university system.

Then just let me make a couple of comments that go beyond the specific issues today. One is that—and I know I do not need to make this argument with you. We ought to recognize that beyond the funding of this bill, the funding of the Pell grants themselves is central to the purposes you are talking about. If we are really going to be entrepreneurial and we are looking to people who are going to be pathbreakers, and so on, then we ought to keep the openess of our higher education system. And we are not going to be able to do that in the coming times unless there is the kind of funding that those grants represent. So I would just urge that for that reason and also for the reason that if we are not very careful in a society that moves toward high technology, we are going to end up being a two-class society. And we have to be very, very careful about that.

I would love to say more about that, but because of time I will pass on. In certain fields—second point—in certain fields, there must be new Federal support of graduate students.

We have talked a lot about the shortage of teachers. There is nowhere that it is more urgent than in certain fields in higher education: engineering, computer science, certain other of the science disciplines. OMB cut back on graduate funding, graduate support years ago when there was a balance of supply and demand. But we are now dangerously out of balance there and that is an area that badly needs attention as these issues come to the fore.

Third, there are two critical areas where resources are needed if we are to achieve both the development of the kind of graduates you want to feed back into the schools, but also to feed back into the kind of industry we are talking about.

And that is in the areas of laboratory equipment and in the areas of library resources. And I know you are aware of both of those. I would put those way up on the priority list of things that are central, both at the elementary—secondary level and higher education.

And then finally, the last point I wanted to make is that in everything we are talking about, it is not simply a matter of whether there is enough money. What we are really talking about is the imagination with which we go at these things, whether we can find ways to spring our imagination. And I would like to suggest a form of Federal intervention which I think has been successful at doing that, and that is the form that was used in the fund for the improvement of postsecondary education.

We have found over and over again as we have gone back and looked at that program that when our institution or other institutions—we have been a recipient of 50 grants. When we go to the trouble of trying to come up with a competitive, imaginative solution, even sometimes when we do not get the grant, we go ahead and find ways to alter the nature of our institution.

But the most important thing is to drive people into thinking how to get out of their shells and come up with new and more imaginative ways to do it.

Even more important than the money is the unlocking of that creativity. So my point, I guess, is that the urgency is not only funding but the form of funding as well.

Senator PELL. I appreciate your comments, and also agree so much with you, Dr. Newman, on the question of the need for greater entrepreneurial drive on the part of our younger people. And as I said earlier, that the real strength of our Nation is the sum total of the education and the character of the people. And this is really one of the points you are emphasizing.

The question is: in a public educational system, how without crashing into the Constitution, do we bring much emphasis upon the character? And this takes, I think, very good leadership in the universities and colleges, and a sensitive faculty to try and have some kind of a rapport with students.

Mr. NEWMAN. I think it is a subtle and difficult problem. It is a lot easier to think about how to provide computers then it is to think about how to provide entrepreneurial skills and character.

And yet if I had to choose, I would take the latter, I suppose, than the former.

I think there are ways to do it. One that is essential as far as this is to realize that there are many things that go on, both in elementary-secondary and in higher education that have to do with character that do not seem to have much to do with what we are talking about now, but turn out to be important.

For example, for years we have gotten away from talking about such things as the importance of the student involving him or herself in participation in extracurricular activities: athletics or the student newspaper, radio station. All those things are critical in terms of the risk taking skill of the student. That is a long subject, and I would love to go on, but I better not.

Mr. SWEET. I was only going to add to that that it seems to me that central to our character building efforts are the teachers in our schools, and critical to that is to be absolutely certain that those teachers are qualified to do that which they are doing. If you want them to provide character building leadership, they really need to do that out of a base of preparation in their subject matter. It is extremely difficult, it seems to me, for teachers to stand up in front of classrooms when they are marginally prepared and provide an ethos of leadership. It slips away from you when you have that marginal preparation.

And I do think that that is a critical part of addressing the problem of inspiring students in schools.

Mr. NEWMAN. May I add just one point? One of the reasons why I think this bill is critical and one of the reasons why the spirit of trying to do something about this problem may turn out to be critical, in a period of declining resources, declining enrollments, the natural tendency of both elementary and secondary and higher education is cooling it, conserve, get back, get your head down, get in the bunker. And that is the worst possible spirit in which to create a sense of entrepreneurship, risk taking, and so on.

Senator PELL. I remember giving the graduation speech at your institution once, President Newman, and the theme of it was do not worry about the daisies. In other words, young people should not worry about keeping the garden in order, but should concentrate perhaps more on learning and reading and not get involved in minutia.

But I thank you. That was the title of it: "Don't Worry About the Daisies."

At any rate, I thank you both very much for being with us. I apologize for the speed with which we have had to go, but we do have these votes on the social security bill this afternoon.

Without objection, the record will remain open for any supplementary statements that any of the witnesses care to make or any questions that we may wish to submit in writing. The responses will not be in printed form probably for a couple of months, and when it is in printed form, it will be available to any who are interested.

I thank again Chairman Stafford for permitting this hearing to be held, and this hearing is recessed on the call of our chairman, Mr. Stafford.

[Whereupon, at 11:40 a.m., the subcommittee was recessed, subject to the call of the Chair.]

EDUCATION FOR ECONOMIC SECURITY ACT

THURSDAY, APRIL 8, 1983

U.S. SENATE,
SUBCOMMITTEE ON EDUCATION, ARTS AND HUMANITIES,
COMMITTEE ON LABOR AND HUMAN RESOURCES,
Washington, D.C.

The subcommittee met, pursuant to notice, at 1:35 p.m., in room SD-430, Dirksen Senate Office Building, Senator Robert T. Stafford (chairman of the subcommittee) presiding.

Present: Senators Stafford and Pell.

Also present: Senator Warner and Tsongas.

Senator PELL [presiding pro tempore]. The Subcommittee on Education, Arts and Humanities will come to order. The chairman, the Senator from Vermont, has requested that we get started, and I know the precious time our colleagues Senator Warner and Tsongas have, so I will ask you, Senator Warner, to lead off.

STATEMENT OF HON. JOHN W. WARNER, A U.S. SENATOR FROM THE STATE OF VIRGINIA

Senator WARNER. Mr. Chairman, I will be very brief because I have to go to an Energy Committee caucus down the hall.

I approach this subject, Mr. Chairman and my distinguished colleague here from Massachusetts, with a great deal of sincerity. I checked into the historic records of the Senate, and I am only one of two Members of the U.S. Senate today that has an engineering degree. I happen to have majored in math and science; and Senator Glenn from Ohio is the other. So when I speak today, it is from a background of complete sincerity of some experience in this area.

The evidence of declining math and science proficiency among American high school and college graduates becomes more pervasive every year.

The most dramatic indicator of this decline is the sheer numbers of students graduating with little or no classroom exposure to math and science, and the erosion of scholastic aptitude test scores.

In part, this decline has occurred because of the reduced emphasis placed on math and science due to the increased emphasis placed on liberal arts education in our Nation's primary, secondary, and higher education systems. In part, this decline has occurred because of the growing scarcity of qualified math and science instructors—particularly in our Nation's colleges and universities.

Mr. Chairman, I would also like to add a personal observation, having gone through this curriculum. I remember very well that those of us in engineering studies, both at the secondary and advanced education levels, had to work most of the afternoons in laboratories while the others had the opportunity to enjoy the athletics and other interesting things afforded by our institutions of learning.

The most widely acclaimed remedy to our current economic plight and the competitive disadvantage we suffer in the world market is "high technology." The computer is the way to the future, yet the emphasis on training America's youth in this new technology is not adequate in America's schools.

Of the declining numbers of math and science graduates who go on to teach, many have been lured away not by retirement, but to private industry, where the financial incentives are greater.

Public schools are losing five times as many math and science teachers to industry as to retirement.

So, what is the solution to this dilemma?

How can this Nation attract and retain more math and science teachers?

How can our varied and separate school systems produce more qualified math and science graduates?

I believe that the range of proposals made in this area by the President and my colleagues in the Senate is a good start.

Mr. Chairman, I would like to submit the balance of my testimony for the record, and now defer to my colleagues.

Senator **Pell**. I thank you very much, Senator Warner. Your remarks will be printed in full in the record, and I am glad you are supportive of this approach.

[The prepared statement of Senator Warner follows:]

STATEMENT OF SENATOR JOHN W. WARNER

Thank you, Mr. Chairman, for this opportunity to address the subcommittee regarding math and science initiatives in the 98th Congress.

The evidence of declining math and science proficiency among American high school and college graduates becomes more pervasive every year.

The most dramatic indicator of this decline is the sheer numbers of students graduating with little or no classroom exposure to math and science and the erosion of scholastic aptitude test (SAT) math and science scores.

In part, this decline has occurred because of the reduced emphasis placed on math and science due to the increased emphasis placed on liberal arts education in our nation's primary, secondary and higher education systems. In part, this decline has occurred because of the growing scarcity of qualified math and science instructors -- particularly in our nation's colleges and universities.

As one of only two engineers now serving in the United States Senate, I find this situation distressing.

The most widely acclaimed remedy to our current economic plight and the competitive disadvantage we suffer in the world market is "high technology." The computer is the way to the future, yet the emphasis on training America's youth in this new technology is not adequate in America's schools.

Of the declining numbers of math and science graduates who go on to teach, many have been lured away not to retirement, but to private industry, where the financial incentives are greater.

Public schools are losing five times as many math and science teachers to industry as to retirement.

So, what is the solution to this dilemma?

How can this nation attract and retain more math and science teachers?

How can our varied and separate school systems produce more qualified math and science graduates?

How can our industry and our scholarship be made more competitive in the world market?

I believe the range of proposals made in this area by the President and by members of Congress is a good start.

I endorse the President's recent proposal to increase the National Science Foundation budget by 18 percent in FY '84 over FY '83.

If funded, I am hopeful that a portion of this budget request could go to the Southeastern Universities Research Association (SURA), to finance the National Electron Accelerator Laboratory, a nuclear science research facility.

SURA is a consortium of 22 universities organized to manage large, cooperative projects in the fields of science, engineering and medicine. The accelerator laboratory SURA proposes to build would be the only one of its kind in the world.

It will symbolize major progress in restoring U.S. leadership in basic physics.

It is a cooperative effort between the public and private sector. It is the needed kind of program to thwart the decline of graduate faculties and restore scholastic challenge and achievement in math and science.

In Tuesday's Washington Post, A. Bartlett Giamatti, President of Yale University, wrote an article on the importance of the private sector/university relationship to promoting academic and industrial excellence. I believe his thoughts reinforce the point I am making before you today, and I include his article as a part of my statement.

Throughout my academic and professional career, I have held that education is the very foundation upon which our nation was built and must thrive.

Last year, President Reagan eloquently reiterated that position when he said, "Our challenge now is to create a resurgence of that thirst for education that typifies our nation's history."

Mr. Chairman, I am confident that the 98th Congress can successfully begin addressing America's math and science education needs, recognizing serious budget constraints.

Your subcommittee has a worthy challenge in consideration of a number of initiatives, including the House-passed Emergency Mathematics and Science legislation. I know you will carefully balance the national interest with the states' primary role of education and with fiscal responsibility.

I am supportive of the task you have undertaken.

THE WASHINGTON POST
April 5, 1983

A. Bartlett Giamatti

Universities and Corporations: Mapping Out Common Ground

Why, I was always asked by friends and others from the corporate world, can't a university be run like a business? Once I was so incautious as to say what I thought, viz: why can't businesses be run more like universities?

When I said it, four years ago, it was taken as a silly comment by an academic who had led a sheltered life. Then came all the books about the techniques of Japanese management, and suddenly American business leaders were heard extolling the virtues of a more consensual (dare I say collegial?) style of management that sounded like the style of administration in a university.

During the same time, the fears in the academy about evaporating federal research funds and the revolutionary new processes in biotechnology began to drive the corporate and university communities closer together. It is clear to universities that money to sustain research may be forthcoming, and that intellectual interaction between the academic and corporate communities may be beneficial.

It is also clear that in order to move products or processes to market in a timely and useful fashion, it will be necessary to have relationships with the corporate world. The corporate world has learned that in order to participate in the great revolution in biological science now occurring so fast, it must attend to the universities where the work is being done. As these two "worlds" move closer, not for the first time and in fits and starts, it is necessary to map out the common ground.

This mapping project means beginning to understand the structure of the university. Without some awareness of how a university is put together, and how it is managed, the conversations with the corporate world cannot really move ahead. What follows are notes to a description of a research university's structure. I do not mean to imply that all universities are the same or that all parts of the same university think alike.

Indeed, that last point begins to get to what is unique in the corporate structure that is a university. It is essential that our friends from the corporate world, who may find the university quirky and mystifying, at least recognize what is at issue. Otherwise, research partnerships will never be more than local deals for piecework, and the larger end to partnership, which is serving the public good by different means, will be lost.

Universities, hierarchical in some ways, are very diffuse, with authority delegated and responsibility widely shared. Thus, a university is a landscape dotted with pyramids of various sizes. It is not one enormous pyramid, solid and entire. There is constant interplay between centralized authority and localized or individual autonomy; interplay among custom, consultation and decree. In the university one constantly seeks the line between being deliberate and being dilatory; one seeks to balance the imperative of equity and the needs for efficiency.

None of this will surprise the inhabitant of the corporate world; similar structures and issues are often common to corporate life. There are, however, more substantial differences. Universities differ from other corporate structures in two essential ways: first, many people participate in the management of the institution; and second, those same people legitimately pursue multiple goals through a variety of means. In other words, while a university has corporate character, it is not that of a business corporation, and cannot be approached as such.

The deepest difference lies, finally, in the competitive environment. The university is a place of competition—within oneself and between people, among ideas, for resources, with other universities. But it is also an institution that, in the interests of furthering its mission of creating and spreading knowledge, cherishes the noncompetitive values of freedom from the need to achieve short-term results or immediate utility and the freedom from proprietary claims or the contention over property rights.

A great university has as its ideal the promotion of the competition of ideas, so that the best may emerge, while precisely not encouraging the financial incentives to competition that obtain in the marketplace. While the university does not always have it both ways, its driving ideal is to make an environment where both competitive and cooperative values exist.

What does all this mean for the management of a university? It means the management of the institution must be conducted in a spirit and manner that do not run counter to the essential purpose of the place: to remain independent and to use this precious asset to promote teaching, scholarship, and the dissemination of knowledge.

It means that the university must be recognized as a conversation the culture has with itself, a conversation epitomized either in the first class freshmen ever have on a bright autumn morning or in the conversation scholars and collections and laboratories and ideas have through lifetimes across generations. It means the appreciation of an administrative style that encourages and guides the conversation without controlling or predetermining it.

The first challenge in partnerships for research is to clarify the differences between the corporate world and the university. Only when each partner begins to understand the norms and needs of the other will corporate-sponsored research, so necessary, so important, so valuable, begin to find a logical and welcoming home in the university.

The writer is president of Yale University.

STATEMENT OF HON. PAUL E. TSONGAS, A U.S. SENATOR FROM THE STATE OF MASSACHUSETTS

Senator TSONGAS. Given what Senator Warner just said, I have to engage I guess in a mea culpa. And that is that when I began my college career, I was a chemistry major, which interfered with swimming practice; so I switched to political science. [Laughter.]

So I guess there are two and a half Senators that have technical backgrounds.

Mr. Chairman, let me submit my statement for the record if I might, since you are a cosponsor of my bill—in fact, I am in some respects preaching to the choir—but let me, if I might, just make a few comments for the record beyond that in my statement.

Senator PELL. Without objection, the statement will appear in full in the record, and I also want to thank you very much; I believe you are a cosponsor of my bill; so we each have a choir.

Senator TSONGAS. I forget who it was that said this, but it has been repeated so often that the authorship is now pretty much lost in the shuffle. There's a U.S. chief executive officer who was talking about the Japanese competition. He said: "My company can take on any Japanese company; I'm not worried about it." He said, "What I'm worried about is my company taking on the Japanese company in Japan." And that is the major imbalance that we are dealing with.

And that kind of sentiment has been voiced by many people, and I think now it is pretty much a given in the country. The issue is very clear; that is, we have to be competitive.

In our part of the United States, as the Senator knows; I grew up in Lowell, which is similar to many of the cities that you represent, and Lowell was the textile capital of the world and it began its decline. I lived through that; and my family was in business and lost their business in that process. I have no desire to go through that again.

Massachusetts is now dependent upon high technology for its future. Indeed, New Hampshire is first, Massachusetts second, Vermont third in the percent of the work force that is involved with high technology. I believe Rhode Island is around ninth. And as a region, we are by far the most dependent upon this industry.

What we are talking about is having an economic strategy so that we can be competitive with the Japanese. Now, the High Technology Morrill Act, which I have filed along with yourself, Senators Hart, Stennis, and Randolph, is not something that we dreamed up in our office. It is a product of a book called "Global Stakes" which I believe you all have been given a copy of.

And the "Global Stakes" group, if you will, is the same group that the President met with when he went up to Boston a couple months ago. They made the argument there of the need to have in place an economic strategy.

The High Technology Morrill Act is a partnership in the best sense of that word; in the sense that the ideas for funding and programs come out of, in essence, a combination of industry and State government, State colleges, State universities, et cetera, and then comes to us for matching grants.

And the whole purpose of the approach is not have a Washington-to-grassroots view of the world; rather, to have Washington sensitive to what is happening out there. And clearly the people who know best what has to happen are the people who are on the cutting edge of the technology. Those are the people that will be devising the program.

I am very pleased that the committee is taking this bill so seriously, and I would hope that portions of it will be contained in the final package which the committee passes out this year.

You know we passed a jobs bill with much discussion before the recess; $4.6 billion. What you are talking about here, and what you have put together and what our add-on hopefully will be will be even more important to this country's long term survival.

I feel very strongly about it. I think this committee should be congratulated for the initiative it has taken. And this bill that is going to come out of this committee, I think it is going to be very important; it will be a clear landmark.

Some day we will look back and say: When did we finally get our act together? I believe this bill will be the first step in that direction.

Senator **Pell**. You are so right, I think. In this very room yesterday some of us were saying that the real strength of our Nation is the sum total of the education and the character of our people. And what you are doing here is pressing in this direction.

Your approach, the approach of some of us in the committee, and other approaches will be blended in together to what I hope to be a successful bill. The financing of it is where we will have problems with the executive branch of the Government.

In my own State, we have developed the Strategic Development Committee which we hope will provide a joint partnership between business, labor, and government, and we hope to have Rhode Island move from being ninth in the United States to eighth, seventh, sixth; coming up to where we should be, in the neighborhood of Massachusetts, which is our next door neighbor.

One question is, your bill which is financed by 3 percent of the royalties from Mineral Leasing Act, would be $500 million a year. Is that correct?

Senator **Tsongas**. That is right. It would be matched by the State/industrial equivalent amount.

Senator **Pell**. And from a technical viewpoint, your bill has been referred here, but it has not been referred to Interior, so we might have problems, I would think.

Senator **Tsongas**. I don't believe that's the case.

Senator **Pell**. It was just referred only to us. Though we might like the idea very much indeed, the idea with regard to financing, that is, we might have difficulties with other committees.

But this is a thing we will thrash out.

Senator **Tsongas**. Well, we chose what we thought was the most rational committee, and this was it.

Senator **Pell**. Thank you. You are absolutely correct in that assumption.

[The prepared statement of Senator Tsongas follows:]

Senator Paul E. Tsongas

April 8, 1983

Testimony Before the Education Subcommittee of the
Labor and Human Resources Committee

Mr. Chairman, our nation is entering a new era of economic growth driven by rapidly changing technology and sharp international competition. The competitiveness of both our high technology and mature industries depends on U.S. scientific and technological leadership -- that is, on increasing rates of technological innovation and productivity. In turn, these goals depend, to an unprecedented degree, on the availability of scientists, engineers, technicians, and managers with the right technological skills. Without these human resources, we cannot remain competitive.

On March 1, I introduced the High Technology Morrill Act, S. 631, to provide the human resources so we can compete. I am pleased to have, joining me in this initiative, Senators Stennis, Hart, Pell and Randolph. Modeled after the Morrill Act of 1862, this legislation would mobilize educational resources to maintain our economic strength in the technological era.

Assessment after assessment shows that we are failing to develop the human resources needed for economic growth. Our technological education is inadequate to meet the challenge of our international competitors. We are failing to provide basic science and math skills to our elementary and secondary school students. We are producing too few engineers, in some fields, and too few of our engineering graduates lack first-rate training. We are failing to keep our workforce current with technological advances, thus wasting the talents of our most experienced engineers, technicians and managers.

Our colleges and universities are hobbled by severe faculty shortages and obsolete equipment and curricula. There is a serious shortage of graduate students, threatening the future supply of Ph.D.s and faculty.

The results are abundantly clear. Math and science achievement scores of precollege students are declining. Enrollments in math and science courses are down, as are curriculum requirements. And, most seriously, we are facing a critical shortage of qualified math and science school teachers. As a consequence, fewer students adequately prepared in math and science are available to enter technological fields.

International comparisons cast us in an unfavorable light. Many other industrial countries are beating us in both the quantity and quality of their technical workforce. Many of them have dramatically upgraded their technological capacity, including their ability to respond to technological change. If we continue to slight technology education, we cannot remain competitive.

There is precedent to suggest that our educational system, if properly assisted, can rise to a challenge of this magnitude. The Morrill Act of 1862 established the land grant college system that helped revolutionize United States agriculture. The "G.I." bill after World War II made undergraduate and graduate training widely available. The National Defense Education Act of 1958 -- the response to Sputnik -- mobilized education to protect national security. The Education Amendments of 1965 responded to demands for greater social justice by expanding educational opportunities.

The educational challenge facing us today requires a new mobilization of educational resources. We must increase the quality of technological education at all levels. This includes raising basic math and science skills of high school students, upgrading science and engineering programs in our colleges and universities, and offering training opportunities for unemployed workers and working professionals with outmoded skills.

Educational institutions cannot handle this job alone. Only through a partnership among industry, schools and government can we adequately mobilize our educational system for economic growth. Industry must play a major role in providing direction, expertise and investment. Some companies have recognized this responsibility. They see their investments in education not just as charitable contributions, but as an important element of their competitive strategy. More and more companies are instituting university programs to strengthen technological education.

Similarly, state governments are also recognizing the importance of technology and education in meeting their economic development objectives. Many states have begun programs to invest in technology education in order to attract new firms.

While these efforts are helpful, they are unequal to the task. Industry's contribution for education, while growing, still represents a very small fraction of the need. For each university helped many more receive nothing. While some states have bolstered technological education significantly, many ideas remain on the shelf for lack of funds.

Federal involvement is clearly required. But the Federal government should build on the initiatives of industry and the states, not compete with them. This is the basic idea behind the High Technology Morrill Act

The bill establishes a competitive grants program to provide matching Federal assistance for joint initiatives of private industry, educational institutions, and state governments to strengthen science, engineering, and technical education. In order for a project to be eligible for the 50 percent matching federal grant, private industry must contribute 20 percent, and states 30 percent, of the total cost. The bill would allot roughly $500 million a year over five years for this purpose.

This bill would not simply throw dollars into education. It is not a quick fix. It would authorize a long-term investment in education and encourage the development of a partnership among industry, education and government.

Why do I propose a partnership of this kind? Requiring industry participation would ensure that activities supported by this bill reflect the priorities of the private sector as it seeks to maintain American technological leadership. The bill's requirement of state participation -- the approval of a governor and a financial contribution of 30 percent -- assures that projects are responsive to the state's economic development strategies, employment policies, and educational priorities.

The bill is comprehensive in scope. It would apply to projects for all levels of our educational system, including elementary and secondary schools, community and junior colleges, four year colleges and universities, graduate schools, and programs for continuing education and job retraining.

The bill is designed to encourage diversity, experimentation, and innovation in approaches to technology education. It could support a broad range of efforts at the local and regional level. It could, for example, fund research/training centers, modernize lab equipment, initiate new technicians' training programs in community colleges, develop continuing education programs for technical professionals, and establish computer literacy programs in schools. The bill also could reinforce efforts to raise educational productivity by development of new educational methods and equipment, teach the management of technological innovation and improve the access of women, minorities, and the handicapped to technological fields.

Like the first Morrill Act, the High Technology Morrill Act seeks to parlay our nation's natural resources into educational benefits. The Morrill Act of 1862 devoted 17 million acres of Federal land for founding agricultural colleges across the country. Proceeds from the sale of the land were invested, and interest earned accumulated in a perpetual fund for the support of the land-grant colleges. Similarly, the High Technology Morrill Act would turn over a small percentage (three percent) of the revenues the Federal government receives from sale of energy and mineral resources on Federal lands into a Technology Education Trust Fund. This fund -- totaling roughly $500 million a year for five years -- would be the source for Technology Education grants. This is a great deal of money at a time of very large federal deficits. But we are addressing an issue of very high priority for this nation. The educational foundation needed to keep this nation technologically competitive is vital to our military and economic security. These investments our nation can ill afford to defer.

The High Technology Morrill Act is one of several bills introduced in the 98th Congress to improve technological education. I support some of these measures, as well. The High Technology Morrill Act differs from the other bills in its emphasis on the partnership among industry, academia and government and its reliance on the private sector to identify priorities for technological education initiatives. Thus, it embodies an approach that is not reflected in other bills. It complements other legislation such as S. 530, the Pell/Stafford bill, of which I am an original cosponsor, and would be a valuable component of a comprehensive package including the best of all bills that have been introduced.

Such an omnibus bill could fuse the interests of government, industry and education into a national policy to ensure a supply of scientific, engineering and technical personnel adequate to ensure U.S. scientific and technological leadership, to maintain U.S. international competitiveness and domestic employment, and to safeguard national security.

Mr. Chairman, I want to thank you and the Committee for seriously considering the ideas contained in S. 631, the High Technology Morrill Act. I would welcome the opportunity to work with you and your staff to work out a means of incorporating these ideas in the legislation this Committee will develop.

Senator Paul E. Tsongas

HIGH TECHNOLOGY MORRILL ACT: FACT SHEET

PURPOSE:

To establish a national grants program providing matching Federal assistance, for joint initiatives by private industry, educational institutions and state government to strengthen science, engineering, and technical education.

RATIONALE:

An adequate supply of scientific, engineering, and technical personnel is essential to ensure U.S. scientific and technological leadership, to bolster U.S. international competitiveness and domestic employment, and to safeguard national security. Our educational system must respond to the economic challenge by improving the quality of math and science instruction at the pre-college level, strengthening and modernizing programs in science, engineering and technology in our colleges and universities, and developing the capability to provide lifelong education and training to our existing technical workforce.

PARTNERSHIP:

This Act would authorize a program of competitive grants for technology education projects and programs jointly sponsored by industry, educational institutions, and state governments. In order to be eligible for the 50% matching Federal grant, private industry would contribute 20%, and states 30%, of the total project costs. This formula ensures that federal funds to strengthen technological education would comport with the economic development policies of the state, educational needs of our schools and colleges, and priorities of the private sector. As a result, Federal funds would be channeled into educational areas that industry identifies as important for maintaining U.S. technological leadership.

ELIGIBLE ACTIVITIES:

Grants made under this Act may be used to:

--modernize university lab equipment;
--establish university research/education centers;
--expand technician training programs at community colleges;
--develop lifelong cooperative education programs to maintain technical skills of the current workforce;
--initiate programs to retrain workers for jobs requiring more technical skills;
--enhance math, science and engineering teaching as a career;
--establish computer literacy programs in elementary and secondary schools;
--improve educational productivity through the development of new educational methods and equipment;
--develop programs to teach the management of technological innovation;
--improve the access of women, minorities and handicapped to the fields of technology;
--encourage cooperative programs between humanities and sciences;
--and support any other programs that strengthen technological education.

High Technology Morrill Act

CRITERIA:

In making grants under this Act, the following criteria shall be used:

- --the activity is not likely to proceed without the grant;
- --the activity embodies innovative approaches not adequately provided by existing public and private programs;
- --the activity responds to clearly established technical education needs of industry;
- --the activities will result in sustained efforts or lasting improvements in education programs and facilities.

The Act also encourages applications involving joint programs between institutions of higher education and elementary and secondary schools, participation of small business, and regional efforts.

FUNDING:

The Act would make available approximately $500 million of Federal matching grants per year for five years. Three percent of the federal revenues from the sale of energy and mineral resources on Federal lands are placed in a Technology Education Trust Fund, which are then made available for grants by annual appropriation.

ADMINISTRATION:

The technology education grants established by this Act are to be administered by the Director of the National Science Foundation. He is authorized to establish an advisory committee representing industry, education, states, professional societies and labor, and to consult with the Secretary of Defense and other agencies to ensure coordination of Federal efforts.

PRECEDENT:

The Morrill Act of 1862 devoted 17 million acres of Federal land for founding agricultural colleges across the country. Proceeds from the sale of the land were invested, and interest earned accumulated in a perpetual fund for the support of the land grant colleges. This act sparked a technological revolution that led to U.S. industrialization and made U.S. agriculture number one in the world.

Senator **Tsongas**. Just one other thing, if I might.

One of the major tourist attractions we have in Massachusetts now are people from other States seeking to duplicate the high technology experience. And I can tell you something, if that pie doesn't keep on growing, there is not going to be any duplication anywhere. And so even though this has been sort of focused in on by the Massachusetts and the Vermonts and the New Hampshires, Rhode Islands, et cetera, the fact is that Michigan, Ohio, and some of the other States are desperate for this kind of technology and don't give us a hand, that pie will not expand and they will have no capacity to move in and in essence enjoy the same benefits that we are enjoying.

Senator **Pell**. You are absolutely right.

Senator **Stafford** [presiding]. All right, thank you very much, Senator Pell, for getting the meeting started. I apologize to all hands. The Senator from Vermont is the chairman of the Environment and Public Works Committee, and we have been involved in extensive hearings in connection with the Superfund, and the troubles and tribulations at EPA, which put me way behind today.

I have a very brief opening statement, but I am going to place that in the record rather than use the committee's time, and the witnesses' time. I regret, Senator Tsongas, I didn't get here in time to hear your statement, but I will review it carefully, I can assure you, and as soon as the opportunity arises.

Senator **Tsongas**. I assure you it was very compelling, Senator.

Senator **Stafford**. Well, yours always are.

Senator **Tsongas**. That is why you are chairman.

Senator **Stafford**. We thank you very much for helping us.

[The opening statement of Senator Stafford follows:]

Opening Statement of Senator Stafford

Senator **Stafford**. I am pleased to convene this fourth day of hearings of the Education, Arts and Humanities Subcommittee to consider the problems of mathematics, science, and foreign language education which our Nation faces. Our first 3 days of hearings have helped us to understand and appreciate that perhaps the greatest of these problems is the shortage of qualified mathematics and science teachers in our secondary schools. Similarly, we need to improve the ability of our elementary school teachers to teach math and science, as well as help school districts to retain qualified teachers.

Much of the Federal role in these areas is therefore catalytic. While the Federal Government can provide support to State educational agencies, school districts, and higher education institutions to improve and expand teacher training, the specific responsibilities to train and employ teachers are in the hands of such entities.

We have an important and interesting group of witnesses before us today, and I know that you will further enlighten us as to the proper Federal role in these critical areas. We look forward to your testimony, and hope to have the benefit of your counsel as we proceed to subcommittee markup on S. 530 next Thursday, April 14.

Senator **Pell**. And Mr. Chairman, I would like to request that there be inserted in the record a statement by Senator Stennis in support of Senator Tsongas' bill, and that should be inserted in the record at this time.

[The prepared statement of Senator Stennis follows:]

April 8, 1983

STATEMENT BY SENATOR STENNIS

SUBJECT: Labor and Human Resources Subcommittee on Education, Arts, and Humanities

Mr. Chairman and members of this fine subcommittee of the Labor and Human Resources Committee, I thank you for allowing me to present this statement today. As you know, this is an extremely important issue and it is one that I have been concerned about for some time.

Mr. Chairman, the unmatched progress and growth of our great Nation over the past 200 years has come in large measure from the leadership of our Nation in the practical application of science and technology. In every field of endeavor--agriculture, space, communications, commerce, medicine, chemistry, energy, and so on--U.S. engineers and scientists have led the way in getting the job done. Their record of scientific achievement has created the most bountiful National and bountiful economy ever to exist, by and large, on the face of the Earth.

But with all of our progress, storm clouds are on the horizon. Some are the result of the pace of the new discoveries in science and technology and the changes are coming at such blinding speed that many of our workers are being dislocated by new machines and by new methods of manufacturing.

Some of the storm clouds are the result of forces which are largely economic. The wage and price battles which characterized the 1960's and the 1970's have weighed heavily on our major industries. Many of these manistay industries, like autos and steel, have not since been able to successfully compete in international competition.

And while higher prices took a heavy toll, there are other factors, some related to our engineering abilities. The most modern auto production plants in Japan seem to turn out autos that have the appearance of being of higher quality by virtue of better fit and finish, and some consumers say that the automobile built by our foreign competitors are more reliable and perform more to their liking.

Mr. Chairman, those are not idle words. Those words are not hurriedly chosen and spoken. I am a stubborn kind of fellow and I was slow to yield to the validity of these facts that I have just related, but I decided we had to face the facts whatever they are, and we have to try to do something about them.

Finally, and most important, there are signs that the United States is beginning to slip in areas of basic research. National testing programs and surveys tell us that recent high school and college graduates are becoming increasingly unaware of math and science. The downhill slide could have grave consequences for the Nation's economy and defense. Our economic prosperity and national security depends on the Nation's ability to reverse this downward trend in education, particularly in the fields of math and science.

The solution will not come easy, Mr. Chairman. In recent discussions with educators in my State, I was told that there are serious deficiencies at all levels of math and science education. For example, over one-half of all new high school math and science teachers do not meet the full requirement for teaching; 10 percent of all college engineering faculty places are either vacant or filled by temporary instructors. I am told that science, math, or engineering graduates right out of college can make more than their professors who have a higher degree. In my State of Mississippi, recent engineering graduates started at $27,000 while beginning high school and math teachers earned $11,000.

Let me call attention to this problem which has been brought to my attention. The demands of our rapidly changing technical environment has placed a premium on engineering graduates. The high salaries paid by industry for engineers have brought masters and doctorate programs to a standstill.

Let me repeat that, Mr. Chairman. We all like to see a prosperous person get a good salary, so to speak. But this states as a fact that these salaries now that are paid by industry for engineers are so high that they have brought masters and doctorate programs in education to a standstill. The net result is that industry is eating its own seed corn. Clearly, we must do something to make teaching of math, science, and other related areas more financially appealing.

This is not just a plea for money or another educational bill trying to put out a limited program. This is the broad search, the broad appeal for a new policy and new methods. Teaching is the second greatest profression. That is what I believe. It is second only to the ministry itself.

I find to my surprise in this field that the school equipment and supply siutation is also in a depressing state. University engineering and research equipment and facilities are outdated and obsolete in many instances. Science equipment for all elementary and high schools is woefully inadequate or nonexistent when considered by the needs of the present demand. Something must be done and done soon to correct this problem.

Our college class of the year 2000 will enter the first grade next year.

Think of that, Mr. Chairman. These little fellows coming in school for the first time this next school year will be the college class of the future, the year 2000.

That generation to which I refer may be the make-or-break generation to assure our future economic strength, our competitive edge in technology and production, and our ability to defend ourselves. This educational problem is urgent. Time has not run out on a solution but the clock is running fast.

Here I refer to the Soviet launching of Sputnik in 1957. This Nation was reminded of the importance of maintaining its leadership in technology. Congress and the Nation got busy.

I remember one witness testified that unless we built a test facility with a thrust of a million pound we would lose the race. Some segments of the press said it was ridiculous to talk about a million pounds of thrust. A short time later, due to the magnificent program we adopted, the thrust that we had then in one test facility was 6 or 7 or 8 million pounds.

We set our goals and passed the landmark National Defense Education Act which provided unprecedented levels of aid to the school system at all levels. We engaged in a bold crash program to land on the Moon.

I remember that I was chairman of the Subcommittee on Military Construction. We were watching the dollars mighty close, we thought. I asked the question, How much did the President recommend?

He said that there was no limit on the recommendation; everything was to be on a crash basis.

These efforts were successful and they worked well together. As we all know, the real meaning of the Moon race was not just reaching the Moon but developing the expertise in the various fields and the technological ability to get there.

The challenge before us now is our economic future and our national defense.

Someone said, "Oh, well, the Senator from Mississippi is always talking about national defense."

I am proud to be able to talk about it some, but I say here now that this challenge is to our economic future. The warning signs are also clearly there to heed. They are common knowledge to all of us--persistent unemployment, slowed productivity, and loss of market share.

In most any office building you go into, the elevator to go up or down has no one there. That jobs has been dispensed with.

I was at a launching of the Navy's newest guided-missile cruiser earlier this year and they announced the crew of the old ship Ticonderoga was 800 men. That was some 80 or 100 years ago. This modern ship with everything said to be one of the greatest ever put together has a crew of 400 men, a reduction of 50 percent.

Everywhere we are turning we are eliminating through our scientific methods the need for the individual to be employed. Something special must be done to meet the needs of our economy to furnish simple employment.

There will not be any magic solution to any of these problems now confronting our Nation, but they must be addressed and those problems must be won.

It will, as it always has, require imagination, discipline, application, and plenty of plain commonsense and hard work.

I am confident that we have the resources to conquer these problems. We have a good foundation already in place to build upon. We have the world's highest student retention rate. Three-quarters of the U.S. children finish the 12th grade. We have the largest public school and university system in the world and the finest school buildings by any objective measure. This is a valuable storehouse of capital which can be used to build on and restore the United States to a preeminent position in sicence and technology.

There is the rub in our present situation, the lack of those key students.

This effort must start in the schools. We need to correct the shift away from the quality of education which seems to be occurring. Our children have proven that they have enormous capacities to learn. We need to address the teacher shortage and equipment problems of our educational plants. We need to address the need for upgrading the education and training of our current engineers, scientists, and technicians.

In this regard, I have joined with Senator Tsongas and others to introduce S. 631, the High Technology Morrill Act. This legislation, in my opinion, would provide much of the needed stimulus to get our educational system headed back in the right direction.

Upon intorducing this bill, I contacted several key education, business, and state government leaders in Mississippi for their input. All their responses were favorable. Some of them had suggestions for improving the bill, and if this committee sees fit to consider S. 631, then I would urge you to consider their suggestions. The most prevailing suggestion is to modify the bill in such a way as to not require a rigid 30/20 ratio of funds coming from state governments and private industry but to allow flexibility in this source of funding. There are also suggestions to authorize the program for up to 20 years, include organized labor, place an emphasis on retraining technical workers, provide construction funds for specialized facilities, etc. Mr. Chairman, I ask you and your committee to look at these letters and determine if in fact some of these suggestions are worthwhile and should be included in your final bill.

Mr. Chairman, I commend you for holding these hearings and I look forward to working with you on the floor of the Senate to pass legislation which will enable this country to gain a firmer hold on its rightful place as technological leader of the world.

Thank you.

HINDS JUNIOR COLLEGE DISTRICT
Raymond, Mississippi 39154-0999

OFFICE OF THE PRESIDENT

March 8, 1983

Senator John C. Stennis
Senate Office Building
Washington, D.C. 20515

Dear Senator Stennis:

I appreciate the opportunity that you gave me to react to the proposed legislation establishing a national technology education grants program that would provide matching Federal assistance to joint initiatives by private industry, educational institutions, and State government. I certainly agree with this legislative initiative. This bill, if enacted would strengthen our science, engineering, and technical educational programs and help us restore American technological superiority.

Specifically regarding your bill, I suggest that:

1. The language describing the joint agreements might include: private industry, organized labor, education, and State government.

2. On page 3, line 33, the parenthesis should read "including community, technical, and junior colleges."

3. On page 6, the reference to "nonprofit organizations" should be clarified. It appears on line 10. It could be included in the definitions section.

4. This particular bill includes the provision that private funding will be included for 20% of the costs, with 30% from local or State sources. May I suggest that the 30% and 20%, as included on page 7, paragraph 2, be flexible enough so that the total of 50% could be any combination so as to add up to 50% rather than the rigid 30% and 20% as outlined. In this area, care needs to be taken to see that the research emphasis of the senior institutions does not work to reduce the fundability of junior college appropriation. Upper level institutions historically have more complex working relationships with industry and can more easily receive matching money.

5. The purposes section, pages 8 and 9, does not reflect the same kind of stress on training technologists that you provided me in your cover letter. I suggest an additional paragraph that might read: "to develop, improve, and expand technical training programs through community, technical, and junior colleges for worker retraining, upgrading, and cross-training, for dislocated workers, and for expanding the skills base of local economies."

Again, I am in complete agreement with the purposes of this bill and certainly hope that something can be done to enhance our ability to train highly technical people throughout our state. If I can be of any further assistance to you in this manner, please do not hesitate to call upon me.

Sincerely,

Clyde Muse

Clyde Muse
President

Board of Trustees of State
Institutions of Higher Learning

3825 Ridgewood Road
P. O. Box 2336
JACKSON, MISSISSIPPI 39205
(601) 982-6611

Office of the
Executive Secretary and Director

RECEIVED WASHINGTON OFFICE
-1 PM 3:17
SENATOR JOHN C. STENNIS

February 23, 1983

Senator John C. Stennis
United States Senate
Committee on Appropriations
Washington, D. C. 20510

Dear Senator Stennis:

Thank you for allowing us to review your proposed legislation to strengthen scientific, engineering, and technical education.

The State of Mississippi is indeed experiencing the problems you have identified. We wholeheartedly agree with your efforts in proposing this legislation.

According to Governor Winter, one of the reasons Mississippi does not attract more high technological industries is the lack of qualified persons who are prepared to work in the industries. This bill would benefit Mississippians by preparing our young people in the technologies and to retrain those whose skills are obsolete.

Mississippi is making state-wide efforts to alleviate a critical shortage of math and science teachers in secondary schools. In October, 1982, a meeting of legislators and educators on the secondary and postsecondary levels was held to plan strategies for solving this problem. As a result of these continued efforts, funding for a math-science teacher education scholarship program has been requested. The enabling legislation has been passed, and we are confident that the funding will be forthcoming. A partnership between secondary and higher education has been formed. In addition, industry is being utilized when possible. With the assistance of funds from state, federal, and industrial sources, we will continue striving toward our goals.

Senator Stennis, we encourage you to actively strive for the proposed legislation, and we offer our assistance in any way possible.

Sincerely,

EEThrash

E. E. Thrash
Executive Secretary and Director

EET:cjm

Mississippi Power Company
2992 West Beach Boulevard
Post Office Box 4079
Gulfport, Mississippi 39501
Telephone 601 864-1211

Alan R. Barton
President

the southern electric system

RECEIVED WASHINGTON OFFICE
1983 FEB 25 AM 11:40
SENATOR JOHN C. STENNIS

February 21, 1983

Hon. John C. Stennis
United States Senate
205 Russell Senate Office Building
Washington, D. C. 20510

Dear Senator Stennis:

I read with interest and enthusiasm the draft of legislation to strengthen scientific, engineering and technical education. I agree that this is a problem that must be addressed now and I am impressed particularly by the approach that you have taken to meet it.

Greater cooperation between the federal government, state government, educational institutions and industry is critical to the success of the proposal. Each has an interest and each bears a measure of responsibility. In all probability this spirit of cooperation has contributed significantly to the success of our international economic competitors.

The provision for strengthening and supporting the faculty members dedicated to the teaching of math, science and engineering is to me one of the most important points in the draft. Their rewards, tangible and intangible, should be commensurate with their education and skill.

Thank you for inviting me to comment on this draft legislation. You may be assured of my support of the principles that it espouses and of my appreciation for your leadership in addressing this critical issue.

Sincerely,

Alan R. Barton

ARB:mcm

C. E. Holladay, Superintendent
George V. Moody, Director
STATE OF MISSISSIPPI DEPARTMENT OF EDUCATION DIVISION OF JUNIOR COLLEGES
502C WALTER SILLERS BUILDING ☐ P. O. BOX 7[illegible] ☐ JACKSON, MISSISSIPPI 39205 ☐ (601) 359-3520

RECEIVED WASHINGTON OFFICE
1983 MAR -1 PM 2 37
SENATOR JOHN C. STENNIS

Honorable John C. Stennis
United States Senate
205 Russell Senate Office Building
Washington, D.C. 20510

Dear Senator Stennis:

Thank you for sharing a draft of proposed legislation to strenthen scientific, engineering, and technical education. The concepts of the proposal appear to be sound and to address national concerns for the decades ahead of us.

The ratio of state funds to private business sources should not be specified, only the provision that this sum amount to 50 percent of the total costs. It may be that within a given state, either entity - state or business - may be willing to provide other than the 30 - 20 ratio reflected on lines 5 through 9 of page 7 of the draft.

We are very interested in developing technology literacy for Mississippi citizens. Federal encouragement and assistance such as outlined in the draft bill should help states address the technology education issued.

Sincerely,

George

George V. Moody
Director

GVM/cs

STATE OF MISSISSIPPI DEPARTMENT OF EDUCATION
C. E. Holladay, Ed.D. • State Superintendent
P. O. Box 771 • Jackson, Mississippi 39205

WASHINGTON OFFICE
1983 MAR -1 PM 2:40
SENATOR JOHN C. STENNIS

February 24, 1983

Honorable John C. Stennis
United States Senate
205 Russell Senate Office Building
Washington, D.C. 20510

Dear Senator Stennis:

I have your letter concerning the establishment of a national technology education grants program to provide matching Federal assistance to joint initiatives by private industry, educational institutions, and State government to strengthen science, engineering, and technical education.

This is a very needed piece of legislation which will help to strengthen educational opportunities for young people in Mississippi and in these United States. I think this will provide an excellent way for the Federal government to encourage states and others to furnish better educational opportunities through the use of funds for training programs in our institutions. Most school systems in our state are having problems in providing the necessary training in math and science for their students. It is very important that these institutions be encouraged to upgrade and make available the very best opportunities possible for the young people who are getting their education in those schools today. I think you will find strong support from the education community for the "High Technology Morrill Act."

If I can be of assistance to you, please feel free to let me hear from you.

Sincerely,

C E Holladay

C. E. Holladay
State Superintendent of Education

CEH/jb

THE UNIVERSITY OF SOUTHERN MISSISSIPPI
OFFICE OF THE PRESIDENT

March 9, 1983

WASHINGTON OFFICE
1983 MAR 14 AM 11:20
SENATOR JOHN C. STENNIS

The Honorable John C. Stennis
United States Senate
Washington, D. C.   20510

Dear Senator Stennis:

Thank you for your letter inviting us to make suggestions concerning the improvement of scientific, engineering, and technical education. Members of my staff and I have reviewed this legislation, "The High Technology Morrill Act," and are very pleased to have an opportunity to make recommendations concerning its implementation.

Such legislation is, in our opinion, long overdue and would certainly find widespread support in our area of Mississippi. However, while the statement of purpose of this legislation is commendable (Section 3, 1-5) in that it would assure adequate supplies of engineers, technical personnel and technological leadership for our nation and would improve the quality of our technical base, it would do so only through the year 1990. It is our feeling that the need for high technology will surely remain with us throughout the twentieth century and beyond. Thus, to terminate such a program after only such a few years would appear to be self defeating. May we suggest that consideration be given to amending this initial bill to encompass at least a 20-year time span. In this way adequate resources will have been made available, over a sustained period, to provide for a sound high technology education base in many sectors of our country. It is our fear that should the initially suggested short time frame of support remain in effect that in the main, the already very large and financially well supported institutions would secure the majority of this program support. A sustained period of funding would allow adequate opportunity for our very excellent, yet admittedly smaller and less wealthy Mississippi institutions to successfully compete for the "High Technology Morrill Act" funds. In this way, the 50% matching requirement placed upon the participating state agency, business organization or educational institution could be spread out over a longer period of time. Mississippi, Mississippi businesses and Mississippi educational institutions would, therefore, be much better equipped to compete favorably for the "High Technology Funds."

Please know that I stand ready to assist you in this most important venture should the need arise. It is an outstanding proposition and I do hope that it obtains support from Congress.

Very truly yours,

Aubrey

Aubrey K. Lucas
President

AKL/drm

MISSISSIPPI
GULF COAST JUNIOR COLLEGE
DR. J. J. HAYDEN, JR., PRESIDENT
PERKINSTON, MISSISSIPPI 39573

JACKSON COUNTY CAMPUS
CURTIS L. DAVIS, EXECUTIVE DEAN
GAUTIER, MISSISSIPPI 39553

JEFFERSON DAVIS CAMPUS
[illegible] W. CAGLE, EXECUTIVE DEAN
GULFPORT, MISSISSIPPI 39501

PERKINSTON CAMPUS
DR. CLYDE [illegible], EXECUTIVE DEAN
PERKINSTON, MISSISSIPPI 39573

GEORGE COUNTY
OCCUPATIONAL TRAINING CENTER
JOHN WARD COOLEY, DIRECTOR
LUCEDALE, MISSISSIPPI 39452

Steve

SENATOR JOHN C. ST

February 25, 1983

The Honorable John C. Stennis
United States Senate
Washington, DC 20510

Dear Senator Stennis:

Dr. Hayden and I have discussed your letter of February 14, 1983, relative to your proposed legislation on scientific, engineering, and technical education. We and other members of our staff are now studying this proposed legislation and would welcome the opportunity to submit more specific suggestions following our study.

For the time being, however, please be assured that we are most interested in this type of legislation. In fact, we have already been working on this and are taking the liberty of enclosing two papers for your information which we have developed addressing these same concerns.

We will follow up on this with you and provide more detailed comments and suggestions in the near future. Thank you for inviting us to comment.

Sincerely,

Barry L. Mellinger

Barry L. Mellinger
Executive Assistant for
Instructional Affairs

klm

Enclosures

ATTACHMENT I

THE NEED TO IMPROVE BASIC LEARNING SKILLS OF MISSISSIPPI CITIZENS

The General Studies Program at Mississippi Gulf Coast Junior College represents a continuing effort on behalf of the college to help those students with academic deficiencies succeed in a higher education setting. Developmental education, as it concerns our program, is an organized effort to upgrade the academic and personal skills of students who have experienced difficulties in academic settings. It assists them in overcoming academic deficiencies, acquiring coping skills to succeed in their new environment, and raising their performance to the level of students in comparable traditional programs. General Studies at Mississippi Gulf Coast Junior College goes beyond remediation of basic skills as seen in traditional developmental programs and includes college level work. The necessity for this kind of program is evident in view of the large and increasing number of students who are entering college with deficiencies in basic learning skills.

A report compiled by our Institutional Research Office indicated that in the State of Mississippi, 255,000 of the 708,000 people in the age group 18 to 34 years have not completed high school. Another 150,000 of this age group have a high school education, but would be in need of some form of developmental education if they were to enroll in college.

Within the Mississippi Gulf Coast Junior College District, 24,000 of the 93,000 people in the age group 18 to 34 years have a high school education, but would need some form of developmental education if enrolling in college. Of all the entering freshmen academic and technical students in the Fall of 1982 at Mississippi Gulf Coast Junior College, 46% scored below 15 on the ACT. Twenty-four percent scored below 12 on the ACT.

These figures reflect the large number of adults, both throughout Mississippi and within the district, who can benefit from developmental programs designed to upgrade their academic skills. The junior college has an obligation to provide this type of training for this segment of the population to assist them in the acquisition of skills that will aid in their development as productive citizens.

The General Studies Program at Mississippi Gulf Coast Junior College provides a non-traditional setting for college level instruction for which academic credit is awarded. Traditional class instruction and individualized lab experiences are combined to provide students who have learning problems the support system which will enable them to make a successful transition to regular, traditional courses. General Studies courses are offered in English, mathematics, reading, and psychology.

All entering freshmen are screened to determine their proficiency in English, math, and reading. Students who do not meet minimum competency requirements are then counseled to take those General Studies courses which correspond to their academic deficiencies or for which they feel a need to receive additional help. Completion of these courses prepares the student for transition to the subsequent traditional courses. Because academic credit is awarded for all General Studies courses, the course content and terminal competencies to be achieved are the same as those in comparable non-General Studies courses. Due to the unique needs of many of the high risk and non-traditional learners, however, the methodology employed in these classes varies from that used in traditional classes. Much greater individual attention is provided in the developmental program.

It should be noted that even though these students are receiving special help, they are still active, successful participants in the mainstream of college activities. Based on academic need, General Studies students may combine traditional and General Studies classes to comprise a full course load. These students are encouraged to participate in campus affairs. General Studies students have been among those receiving such honors as "Who's Who" on campus, "Who's Who" in American Junior Colleges, Hall of Fame, and Honors and Special Honors at graduation.

Of the 582 academic and technical graduates on the Jackson County, Jefferson Davis, and Perkinston Campuses in the Spring of 1982, 156 were General Studies students.

In summary, developmental studies provide a vital service to adults in this district. It gives them an opportunity to receive additional training that might not otherwise have been available to them because of some learning difficulties they have experienced. The need for these services is apparent throughout Mississippi. The junior colleges must continue to address the needs of the people served by these programs.

ATTACHMENT 2

THE NEED TO MEET THE EDUCATIONAL NEEDS PRESENTED BY RAPIDLY INCREASING HIGH TECHNOLOGY IN BUSINESS AND INDUSTRY, CHIEFLY MATHEMATICS AND SCIENCE

High technology is increasingly becoming a key concern to educators. As industry turns to the latest scientific developments for the fastest and most efficient means of production, the skills and knowledge needed by their employees will change. This has direct implications for secondary and particularly higher education programs. Educators must examine their instructional programs to determine the extent to which they keep pace with the changing needs of industry.

High technology can be defined as the application of advanced scientific methods in industrial processes. Napoleon Moses (1982) defined high technology as "the application of new or different techniques, tools, or equipment, that are the 'state of art' for a particular industry sector". The latest developments in this area cover a broad spectrum. Some of the technologies include nuclear technology, laser technology, laser-electro-optics technology, mechanical technology, energy conservation and use technology, microelectronics technology, genetic engineering, telecommunications, computer applications, robotics, computer-aided design/computer assisted manufacturing, word information processing, and communications technology. All of these technologies require competency in mathematics with some science background. Many require a strong science background and advanced mathematical skills.

Bowden (1982) notes, however, the trend toward decreasing numbers of students preparing for careers in scientific and mathematical fields. Many are not prepared to meet the minimum standards for college-level programs in these disciplines. With this in mind, serious efforts need to be made to help the general public become more scientifically literate. Their support can become the starting point to change the prevailing attitudes of younger students from that of apprehension toward science and technology to one of keen interest and dedication to study in these areas.

Consideration should be given to providing incentives for students to pursue careers in science and mathematical fields. The provision of these incentives should also extend, however, to the instructors in these areas to encourage them to stay in education, rather than transferring to industry where greater salaries are a powerful enticement. Assistance needs to be given to institutions not only to provide competitive salaries for instructors, but also to purchase and maintain the expensive equipment necessary to train students in high technology fields.

Attempting to address the needs of industry in high technology presents many concerns for higher education institutions. Briefly, the institutions are seeking ways to do the following:

1. Develop community awareness for the important effects technological advances have for individuals, the community, and the nation.

2. Provide encouragement and incentives for students to pursue careers in scientific and mathematical fields.

3. Provide competitive salaries to keep instructors in education rather than having them transfer to industry for the prospects of higher income.

4. Acquire the financial ability to purchase and maintain the equipment and materials necessary to develop and operate high technology training programs.

ATTACHMENT 3

THE ROLE OF THE PUBLIC EDUCATION SYSTEM IN MISSISSIPPI IN IMPLEMENTING THE JOB TRAINING PARTNERSHIP ACT

For a number of years, the Comprehensive Education and Training Act (CETA) has provided federal funds for education and training in Mississippi to supplement the vocational-technical training provided in public secondary schools and junior colleges in Mississippi. The Congress has passed new legislation to replace CETA, effective October 1, 1983...The Job Training Partnership Act (PL97-300). It is anticipated that this new legislation may make available approximately $14,000,000 for education and training in the State of Mississippi. Obviously, this will represent a substantial annual expenditure for education and training in Mississippi. All of us should be vitally concerned with the planning for implementation of this new legislation in Mississippi to insure that it supports most effectively continued social and economic growth of our state.

The provisions of the new Act offer considerable latitude to the state in the selection of alternative administrative structures for implementation of these programs. While I will not try to deal with all of the specifics here, it is apparent to me that two major principles should guide our efforts as the state moves to implement this important program.

First, this new program, which differs significantly from CETA, should be planned in Mississippi to supplement and complement the vocational-technical training provided through the State Department of Education in the state's public secondary schools and junior colleges. To do otherwise, would only fragment our efforts and result in less than optimum success in meeting the great need for education and training we have. Certainly, every effort should be made to develop an administrative structure and a delivery system which would minimize duplication of effort and conflicting roles of the various training agencies in Mississippi.

Second, it is essential that the educational programs to be provided under this Act be based upon the educational needs of our people and of business and industry in the state. Therefore, it will be of paramount importance that we insure in planning for this program that mechanisms are established to insure that opportunity is provided for business and industry to identify education and training needs upon which programs will be based. Certainly, the quality of this advise and counsel will depend upon the quality of the people chosen to present the educational needs of business and industry and these individuals should be selected very carefully.

High technology is increasingly becoming a key concern to educators. As industries turn to the latest scientific developments for the fastest and most efficient means of production, the skills and knowledge needed by their employees will change. The importance of high technology can be seen in the remarks of Dan Hull, President of the Center of Occupational Research and Development in Waco, Texas:

> "We're not dabbling in high technology just because its futuristic, glamorous, or an egotistical venture for the scientific community; we're jumping head-on into high technology because we're trying to catch up on the several years lead held by Japan and Western Europe--a lead that is costing the United States millions of dollars each day in the competition world market for newer, better, and less expensive goods and services".

Rapid advance in technology (Update, 1982) have created an "information revolution". This knowledge explosion has implications for the professional training people receive. In some fields, such as medicine or engineering, it has been estimated that the half-life of information acquired in professional school is approximately five (5) years (Lindsay, Morrison, & Kelley, 1974). Consequently, not only must people continue to learn throughout their lives to keep their professional knowledge current, but educators must examine their instructional programs to determine the extent to which they keep pace with the changing needs of industry.

What, then, is high technology? High technology can be defined as the application of advanced scientific methods in industrial processes. Napoleon Moses (1982) defined high technology as "the application of new or different techniques, tools, or equipment, that are the 'state of art' for a particular industry sector". The latest developments in this area cover a broad spectrum. Some of the technologies include nuclear technology, laser technology, laser-electro-optics technology, mechanical technology, energy conservation and use technology, microelectronics technology, genetic engineering, telecommunications, computer applications, robotics, computer-aided design/computer assisted manufacturing, word information processing, and communications technology. All of these technologies require competency in mathematics with some science background. Many require a strong science background and advanced mathematical skills.

The new machines created by high technology will not necessarily replace the workers, but the roles of workers will drastically change (Hull, 1982). The rapid advancement of technology requires a workforce that uses more mental abilities and less physical abilities (Lynch, 1982). This has direct implications for secondary and particulary higher education programs. The subject matter, the kind of student, the teaching methods and materials, and the program financing will all be affected by the impact of high technology. In order to meet the demands created by the development of high technology, educational institutions must move carefully but rapidly to restructure their curricula, equip their programs with current tools and materials, and assure that their faculty are knowledgable in the latest technologies (Hull, 1982). It is important to examine the implications high technology has for three areas of concern to educators - the curriculum, the student, and the faculty.

Curriculum

Most of the literature concerning the implications of high technology for education indicates that math and science offerings must be increased or strengthened. The great majority of the new technologies require a strong science and/or math background. Hull (1982) identifies some of the major characteristics of high technology and their resulting implications for curriculum design. He felt that technicians should have a broad knowledge base. They must be able to understand the principles that govern the entire system with which they work.

Heavy computer use is another important aspect of high technology. Technicians must be trained in the development, use, and maintenance of computerized equipment. Technological advancement is characterized by rapid change, thus technicians must be able to learn new techniques and acquire new knowledge after employment.

Technicians must not only operate high technology equipment, but also broadly understand the operation of the equipment. Because this equipment may be composed of electronic, mechanical, pneumatic, hydraulic, electrical, thermal and optical devices, Hull recommends the development of a "supertech" or a systems-oriented technician with interdisciplinary skills and knowledge. Development of a system orientated technician also has the benefit of providing employee flexibility. This is particularly important where machines continue to take over performance of tasks that workers were trained to do.

Another aspect of curriculum development to be examined is the equipment and materials necessary to implement new programs. Much of the equipment needed is very expensive and may be outdated quickly (Centergram, 1982). When developing these programs, institutions must acquire the financial ability to purchase and maintain the expensive equipment necessary to train students in high technology fields.

In a study conducted by Napoleon Moses (1982) with the Research and Curriculum Unit for Vocational-Technical Education at Mississippi State University, five major types of high technology equipment of particular interest to Mississippi industries were identified. They included the following:

1. Computer Numerical Control (CNC) Equipment;
2. Programmable Controllers;
3. Electronically Controlled Robots;
4. Computer-Aided Design/Computer Assisted Equipment;
5. Advanced Office Technologies Equipment.

The study found that programmable controllers appear to be the most widely used in Mississippi of the high technology equipment. The report also indicated that even though there was not a heavy concentration of robots in Mississippi industry, it is the coming trend in technology applications. With this in mind, Mississippi needs to prepare for change.

Students

As noted previously, most of the new technologies require a strong background in science and mathematics. Bowden (1982) notes, however, the trend toward decreasing numbers of students preparing for careers in scientific and mathematical fields. Many are not prepared to meet the minimum standards for college-level programs in these disciplines.

A report by the National Science Board Commision on Pre-College Education in Mathematics, Science, and Technology noted the declining student achievement in mathematics and science as indicated by declines in scores on several national assessments. The Commission felt that our educational systems must be committed to and capable of achieving three important goals if we are to meet the needs of an increasingly technological society. First, we must continue to develop and increase the number of students who are prepared and motivated to pursue careers in engineering, math, and science. Secondly, we must broaden the range of quality mathematics, science, and technology programs in education at all grade levels. Finally, we must strive to help the public become literate in the technology areas.

One possible solution would be to provide incentives for students to pursue careers in science and mathematical fields. This could take the form of scholarships, tuition reimbursement, or special low interest school loan programs.

Faculty

The provision of incentives should also extend, however, to the instructors in these high technology subject areas to encourage them to stay in education rather than transferring to industry where greater salaries are a powerful enticement.

A 1982 report of the Southern Regional Education Board called attention to the critical shortage of mathematics and science teachers. In the last decade, there was an eighty percent (80%) reduction in the number of secondary mathematics teachers who were newly employed. Teacher shortages in mathematics, chemistry, physics, and earth science are above average in the Southeast and South Central Region.

The existing shortages are to a large degree related to pay differentials. As reported by the NSTA, there are five teachers leaving for non-teaching jobs for every science and math teacher who retires. Thus, institutions must be sure that their salaries and/or benefits are competitive with industry if they are to attract and retain the quality instructors they seek in the high technology fields.

One major concern that faculty should address is the necessity to keep current in their professional fields of study. They should interact with industry representatives as often as possible through on-site tours, attendance at professional meetings and by hosting workshops for industry to acquaint them with our programs.

Recommendations

In summary, attempting to address the needs of industry in high technology presents many concerns for higher education institutions. Specifically, Mississippi Gulf Coast Junior College should consider the following recommendations for keeping pace with rapid technological advancement.

1. Develop community awareness for the important effects technological advances have for individuals, the community, and the nation.
2. Provide encouragement and incentives for students to pursue careers in scientific and mathematical fields.

3. Provide competitive salaries to keep instructors in education rather than having them transfer to industry for the prospects of higher income.
4. Acquire the financial ability to purchase and maintain the equipment and materials necessary to develop and operate high technology training programs.
5. Survey industry to determine local technology applications and job projections for the future. Use the information obtained in this survey to review existing programs and modify them when necessary to meet the needs of industry.
6. Continue to provide strong developmental programs to help remove student academic deficiencies, particulary in math and science.
7. Examine flexibility of the rapid development, operation, and maintenance of the high technology programs.
8. Host workshops for industry to show the new developments in institutional training efforts.
9. Develop a co-op program for students so that they will have the opportunity to have on-the-job experience in their selected field of study as well as enhanced employment prospects upon completion of the programs.
10. Examine the feasibility of including basic computer literacy as a requirement for graduation.
11. Review the mathematics and science course offerings to determine if they need to be increased.

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P. O. BOX 168 BILOXI, MISSISSIPPI 39533
TELEPHONE 374-1810 SUPERINTENDENT OLON E. RAY

RECEIVED WASHINGTON OFFICE
1983 MAR -9 AM 9 42
SENATOR STENNIS

February 28, 1983

Senator John C. Stennis
United States Senate
Washington, D. C. 20510

Dear Senator Stennis:

Thank you for allowing me to respond to the bill which is entitled the "High Technology Morrill Act." I wish to offer a general reaction and also some specific responses.

Overall, I consider the purpose and provisions of the bill to be good. There is indeed a need for us to address technological needs of our country. I believe that the approach recommended in this bill represents a realistic method of partially addressing these needs.

In offering specific recommendations, I must suggest that two or three things be considered. First, I believe that there is a considerable group of very talented individuals who are trained in technical areas where there is not sufficient employment at the present time. Some consideration might be given to retraining these people for areas of employment where there is the greatest need. I also believe that the commitment to public elementary and secondary schools should extend far enough to make federal funds available to provide for materials and some construction of specialized facilities. On page 9, line 2, reference is made to providing assistance for graduate students. I believe that the benefits of this program should extend downward to undergraduate students so we may encourage entry into these important fields. Our schools will find it very difficult to obtain an adequate supply of math and science teachers during the remainder of this decade.

Again, I am favorably impressed with the support and direction of this proposed legislation. I particularly like the idea of providing for cooperation among private industry, the federal government, and the state and local educational agencies. Again, thank you for the opportunity to react to this bill.

Sincerely,

Olon E. Ray, Superintendent

OER:wm

INGALLS
Shipbuilding
Litton

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SENATOR JOHN C. STENNIS

March 3, 1983

The Honorable John C. Stennis
United States Senator
Washington, D. C. 20515

Dear Senator Stennis:

This letter will acknowledge your correspondence of February 14, 1983, addressed to Mr. Leonard Erb, President Ingalls Shipbuilding, in which you had forwarded to us a copy of your proposed legislation for improving the quality of technical education in our Nation. Len has discussed your Bill with me and asked that I respond on his behalf to provide you with our comments.

We wholeheartedly share with you the opinion that there has been, and continues to be, a severe erosion in the quality of technical and scientific education being offered through the public and private educational institutions of this county. As an industrial organization, we feel that there are direct benefits that Ingalls Shipbuilding and the other industrial employers in the State of Mississippi could derive from an improved technical education program. These benefits would encompass such worthwhile objectives as upgrading of the scientific and technical state-of-the-art knowledge of current employees, and among other attributes, the program would help to develop students not yet in the work force for suitable future technical opportunities with Mississippi employers, as well as employers of other states.

You have produced a very comprehensive document, to which I can add very little. Some considerations that occur to me as I read through the Bill are:

> A potential problem exists with the financial ability of a state supported school system being able to assume a sharing amount with private enterprise so as to take advantage of the federal matching grants. The state educational institutions and state finances are already badly strained, and requiring a 30% designation of funds as the educational institution's share of acquiring a federal grant might be somewhat difficult. Your proposed legislation appears to require the "triad" concept between state or local government and private industry, together with the federal government as a prerequisite for obtaining a federal grant. I guess the question in my mind here is could a private employer obtain a matching grant from the

federal government without the third part of the triad participating; that is, without the state or local government participation.

Another potential consideration is publicity for your program, once it passes the Congress. Too often good programs, such as the one you are proposing, are unsuccessful because of a lack of adequate publicity. Perhaps a certain amount of funds should be set aside for adequate publication of the program, and you may want to consider the incorporation of such a provision in the legislation.

Finally, one other consideration that occurs to me is a strengthening of the concept that applies to Section 8 ¶(2), wherein you are discussing the need to improve quality of technical education via teacher training. I feel our shortcomings in allowing the quality of technical education to erode can be attributed, at least in part, to the career outlook and philosophy of those people who today are young adults in our society. During the 1960's and 1970's more emphasis and publicity was given to social sciences and social engineering at the expense of the sciences and math, which is the exact reason you are proposing this legislation.

It is my opinion that an individual forms his or her values between the ages of 10 and 20, and that these values will shape their entire life's outlook, unless some traumatic event should occur that would cause a transition of values to some other philosophy. The kids who formed their values during the 1960's and 1970's are now the instructors who will also be shaping and causing the formation of values for future generations. It would seem to be extremely important that stronger inducements be given to students currently in elementary and secondary schools to pursue a technical education. This stronger inducement has to come from instructors who themselves are genuinely interested in imparting a technical philosophy to their students.

Because of the recent past emphasis on social science, I can only imagine that there is a severe national paucity of technically oriented instructors in the elementary and secondary education programs. Your legislation might try to address the subject of developing more instructors at the lower levels to guide the students toward technical and scientific training.

I think the entire Bill is excellent and certainly extend my congratulations to you for having done your usual masterful job.

Again, thank you for giving us the opportunity to preview this legislation, and your continued interest in Ingalls Shipbuilding is appreciated.

Very truly yours,

Jerry St. Pe'
Vice President
Public/Industrial Relations

Senator STAFFORD. The Chair would invite panel 1 to come to the witness table.

Senator Huddleston has been called downtown, and we will defer to him if he is able to get back here.

Panel 1 is Dr. Quincalee Brown. Maida Townsend, well known to me, whom the airlines allowed to get here today, who is president of the Vermont National Education Association. Mrs. Jessie Roberts, science teacher, Welch Junior High School, Welch, W. Va. And Maudine Cooper of the Urban League also is on this panel, If she would come forward.

[The prepared statement of Senator Huddleston follows:]

Statement of Senator Walter D. Huddleston
before the Subcommittee on Education, Arts and Humanities
April 8, 1983

Mr. Chairman, I appreciate the opportunity to appear before the Subcommittee today on the final day of hearings on math and science education.

The Subcommittee has heard from a number of my colleagues and various public witnesses on the problems we are facing in retaining qualified math and science teachers and offering effective programs. There is no need to review the statistics that show a decline in math and science education. I will only note a few things that I believe the Subcommittee should consider when marking up a consensus bill.

First, and possibly most important, we should remember that the shortage of math and science teachers is occurring now, in 1983. I am not telling you anything new; however, I believe it is important to reiterate it.

I am proud to note that my home state of Kentucky has addressed the need for upgrading our math and science programs. In 1982, the Kentucky General Assembly passed legislation that was designed to attract and retain qualified teachers in the math and science fields in grades 7-12.

This bill has gained the attention of many state legislatures, as well as various national leaders in the math and science areas. Yet, this program, along with others enacted in the past few months by other states, is only a small step in the right direction.

There are a number of good math and science bills, which have been introduced by my colleagues, that give the states a great deal of latitude in designing programs to retain qualified teachers. This is a good idea for the long-term, however, I believe the states need some direction from the federal government in addressing the teacher shortage for the short-term.

The bill I introduced on March 24, S. 923, was drafted to provide some short-term assistance to the states. It would encourage currently certified elementary and secondary teachers to take a sabbatical from teaching to earn a degree in math or one of the sciences. Because the requirements for the degree would have to be completed within two years, new math and science teachers would be available shortly after enactment of the legislation.

I strongly urge the subcommittee to consider the importance of including short-term incentives to the states that will quickly increase the number of new math and science teachers. When these incentives are combined with the other programs that have been recommended by my colleagues over the long-term, we will have taken a major step toward insuring that qualified math and science teachers will be available to meet the needs of the high technology era we are now entering.

I also encourage the committee to report a responsible, integrated bill that does not just throw money at the states. There are needs on the elementary, secondary and higher education levels for upgrading math and science education. The federal government should be a partner to the states in meeting these needs, not just a benevolent father.

Money for new math and science equipment will do the students and the schools little good if we don't have qualified teachers. Funding for colleges and universities to upgrade math and science education will not help if we don't give teachers and college students incentives to enter and stay in math and science education. All of the parts of our bill should be interwoven to insure that they compliment one another.

Finally, I want to bring to your attention the need for making this endeavor a joint effort that includes educators, business people and industry representatives. High technology is becoming a part of everyone's lives, not just a chosen few.

Computers are being used in such everyday activities as grocery shopping and banking. Many small businesses are finding that high technology can increase their efficiency and help to reduce costs.

It is imperative that we have some means of bringing together both the teachers of the basics of high technology and the users of high technology. It will be useless to upgrade our math and science programs if the students who are receiving training are incapable of using computers and understanding the concepts on which they are based.

A State Council on Mathematics and Science Education, as proposed in S. 923, would be an appropriate starting point for this education and business cooperation. It might be feasible to expand on the idea in many states by encouraging similar efforts on the local level. In any case, there must be a vehicle to enable these groups to work together to examine the needs of the state and our country for students educated in math and the sciences.

Before I end, I want to commend the members of the Subcommittee, as well as my colleagues who are not members of this committee, for recognizing the need to take immediate steps to resolve our problems in this area. Several excellent bills have been introduced in the Senate in the past couple of months.

I know the Subcommittee has a great deal of work to do before a final product is brought before the full Senate. I offer any assistance I might be able to give to this process. I look forward to a math and science education program that will meet the challenges of the high technology era.

Senator STAFFORD. Out of the deep respect and affection which both Senator Pell and I have for our colleague Senator Randolph, I am going to lead off the witnesses with Ms. Jessie Roberts.

And I want you to know that Senator Randolph has left a brief statement which I am going to read into the record. I like the first paragraph especially because it says: "Mr. Chairman, I am deeply grateful to you and to your staff for the courtesy you have shown me in permitting me to invite an additional witness to today's hearings."

Now, you always like to read something like that from a member of your committee. This is Senator Randolph speaking:

> I want to welcome Ms. Jessie Roberts, a teacher at Welch Junior High School, Welch, W. Va., where she teaches ninth grade science. I appreciate her gracious acceptance of our invitation to testify.
>
> I would have much preferred to welcome Ms. Roberts in person, but an emergency board meeting at Salem College requires my presence in West Virginia at this hour. I wanted to personally congratulate Ms. Roberts, and to honor her for an outstanding achievement as a teacher of science.
>
> We have heard much about what is wrong with science and math teachers during this series of public hearings, but very little about those teachers who are doing excellent work with their students.
>
> Ms. Roberts has an enviable—if not unequalled record—and one that we can all be proud of.
>
> Let the Record show that Ms. Jessie Roberts, science teacher, has such ability to inspire and motivate her science students that five (5) of them were selected last month as winners in the 1983 Space Shuttle Student Involvement Program competition, sponsored jointly by NASA and the National Science Teachers Association.
>
> Now I know that it isn't exactly news when a science teacher has one of her students selected as a winner in a regional science competition.
>
> But it is news when one teacher has five (5) of her students selected as winners in such competition—competition against students from 6 States and the District of Columbia.
>
> Ms. Roberts, when I was advised of this fine achievement by you and your 9th grade students, you were described as a national resource. I could not agree more.
>
> Congratulations.
>
> To the audience and other witnesses present today, I say to you that there are few earthly things more splendid than the freeing of the minds of men and women who, when urged on to full and fair inquiry, will bring wisdom into world affairs.
>
> As long as we have teachers like Mrs. Jessie Roberts, who uphold the dignity of thought-and learning, our schools will be able to exact standards in the fields of math and science that will surely produce gifted and talented future teachers for American youths.
>
> Ms. Roberts, you have given these young people the close companionship for which youth longs, and the chance for endless discussion and application of scientific themes—which are endless.
>
> I thank you, so very much.

We would invite you to go ahead Ms. Roberts. We understand all of the witnesses have been asked to summarize their written statements in 5 minutes, and we would appreciate it if you can do that.

We never have enough time for important witnesses and it always means we have to go and spend part of each evening reading over testimony we didn't have time to hear verbally presented to us.

So Ms. Roberts, the floor is yours, and I guess the lights have been cued for 5 minutes, which means you will have green for 4 and yellow for 1, and then you are running the lights.

Ms. Roberts?

STATEMENT OF JESSIE S. ROBERTS, SCIENCE TEACHER, WELCH JUNIOR HIGH SCHOOL, WELCH, W. VA.; DR. QUINCALEE BROWN, EXECUTIVE DIRECTOR, AMERICAN ASSOCIATION OF UNIVERSITY WOMEN, WASHINGTON, D.C.; MAIDA TOWNSEND, PRESIDENT, VERMONT NATIONAL EDUCATION ASSOCIATION, MONTPELIER, VT.; AND MAUDINE COOPER, URBAN LEAGUE

Ms. ROBERTS. Thank you, Mr. Chairman. It is an honor to be here. I am a ninth grade physics and chemistry teacher at Welch Junior High School in McDowell County, W. Va. I have 5 years of college teaching experience in biology, and received a master's degree in research from the University of North Carolina, Chapel Hill, under the direction of Dr. Charles E. Jenner.

Mr. Chairman, although I have not reviewed the science and math initiatives before the subcommittee, I would like to speak to you as a teacher. It is encouraging to me as an educator and a scientist that the legislature is concerned with the decreasing numbers of mathematicians and scientists in our country, and the inability of public education to attract teachers in these areas.

I have been increasingly frustrated over the past years having seen the high school requirements for graduation lowered in math and science. As a scientist, when I view our world, I see a rapidly exploding new age of space shuttle successes alluding to the future colonization of space. I see computers moving from the business place to the home. I see robots performing sophisticated functions in industry, and I anticipate robots performing sophisticated functions in the home, all at Timex-Sinclair prices.

But where will the scientists and mathematicians come from to man this new age if there are not teachers there to teach them? We need teachers, teachers of all disciplines, to produce them along with an educated public who can understand them.

I believe that just the concern of this great legislative body will cause change for the status of math and science in our country. If you consider us important, then we become more important. Your programs will in themselves make us more visible in the public eye. Should you choose well, and provide us with programs that have impact, we will be truly benefited.

Two issues prevail; low pay and heavy classloads. Neither one of these issues is directly in your power to change. Federal funds can be spent to educate new teachers, or retrain existing teachers, but it is just the tip of the iceberg. Once you get them into public education, how are you going to keep them there?

I have taught for 2 years with no funds to replenish my science lab supplies. So we do experiments in chemistry on sugar and salt and sand which the students can bring in from home. I have taught for a year with only a box of chalk as a replenishable teaching supply. Next year will be my second year without a pay raise. I teach 150 students a day in overcrowded classrooms.

I would suggest that education emphasize what it can offer to attract and retain science and math teachers; namely side benefits. Side benefits would be a low cost option to make teaching more attractive without directly increasing the pay or reducing workloads.

One such option is time sharing. Two teachers sharing a year; alternating semesters or quarters or perhaps alternating years.

A second option would be part-time teaching, with hospitalization and retirement plans.

A third possible option would be a 4-day workweek.

Another option perhaps, paid sabbatical leave of absence.

For many teachers, more money isn't the major priority in their profession. This has to be true for the teachers you already have, and if the side-benefits were better, perhaps more math and science professionals would go into teaching for these benefits, despite the workload and lack of appropriate pay.

Senator **Stafford**. Thank you very much indeed, Ms. Roberts. I think we'll now move to Maida Townsend. I take pride in saying Maida is from my State of Vermont where she is a most distinguished teacher and heads the Vermont Education Association.

Maida, welcome to Washington again.

Ms. **Townsend**. Thank you, Senator.

Senator **Stafford**. You are going to have to pull that mike up close; our mikes aren't very good here.

Ms. **Townsend**. Senator Stafford, Senator Pell, I am Maida Townsend, president of Vermont NEA, the State affiliate in Vermont of the National Education Association. I am also by profession a teacher of foreign language.

We are currently mired in an abysmal situation with regard to math and science education. No one would reasonably argue otherwise. The factors range from teacher supply, to program requirements, to student expectations and achievements. I firmly believe, however, that as unhealthy as is this current math-science dilemma, the crisis in education is much more broad based and seriously undermines our Nation's economic and social health as well as our military capacity.

Low salaries and demoralizing working conditions have resulted in 36 percent of all of our teachers saying that they probably or certainly would not choose teaching again. In 1982, a total of only 4.7 percent of all college freshmen aspired to teaching careers in any discipline, compared to 21.7 percent in 1966.

In Vermont, last year, we experienced shortages of qualified teachers not only in math and science, but also in business education, industrial arts, English, foreign languages, and reading.

Elementary students are typically exposed to 1 hour of science and approximately 3½ hours of arithmetic per week.

In 1980, only 55 percent of college-bound seniors had completed 3 or more years of math, and only 41 percent had completed 3 or more years of science. Only 4 percent of all our high school graduates are now studying a foreign language for more than 2 years, and only 8 percent of our colleges have maintained admissions standards for foreign languages.

Many collages and universities, additionally, have no general graduation requirements in math or science or foreign languages.

Clearly, all levels of the education community bear a share of the responsibility for curing these and their related ills. And believe me, no one more than educators could want to cure them. But long-term, nationwide success is simply impossible without a turnabout in the degree of both philosophical and financial support which public education receives nationwide, through all levels of Government.

Essential to that turnabout, I believe, is a national commitment and leadership, a national "setting an example" if you will. Until the Federal Government reaffirms its commitment to public education and, in so doing, gives renewed impetus nationwide to excellence, to equal access, and to equal educational opportunity, States and local districts will be left either to struggle under an unreasonable burden or, quite simply, to evade their responsibility.

What Federal measure might best serve as the vehicle for the needed renaissance? Of S. 706, the administration's proposal, and S. 530, the Education for Economic Security Act, and S. 553, the American Defense Education Act, I suggest that the last, the American Defense Education Act, would provide the most comprehensive, long-term solution.

The administration's proposal addresses only math and science, and only at the secondary level, and only the teacher-supply issue, and with only $50 million, $50 million taken from already existing education money.

S. 530 is a far better approach. It goes beyond only the math-science disciplines; it involves all levels of education; it has a much healthier amount of money attached. Three elements of S. 530 trouble me, however. First, the 50-percent matching of funds. Although such a requirement would establish buy-in, both literally and figuratively, it could also lock out poorer districts or those which simply were not willing to make such a commitment.

Second, the lack of flexibility and potential for bureaucratic entanglement. Effectiveness and efficiency in addressing local education needs would be seriously jeopardized by the rigid structure imposed by the percentages for the various disciplines and for the various levels, all administered through the State.

Third, the $400 million. Clearly, a great deal of money. But I ask if even that amount is sufficient, considering the magnitude of the problem. In contrast, the American Defense Education Act, while also addressing a broad spectrum of disciplines, would provide a minimum of about $50 per student in the first year, as well as the possible doubling of that amount if the ADEA-supported programs were successful.

That incentive would surely effect buy-in without potentially shutting someone out. Furthermore, ADEA is ultimately flexible from an operational standpoint. It clearly allows unemcumbered local solutions for local educational needs under accountable local control involving not only a broad spectrum of participants but also cooperation among all levels of education in effecting those solutions.

Thank you.

[The prepared statement of Ms. Townsend follows:]

Statement of Maida F. Townsend, President, Vermont-NEA

I am Maida Townsend, President of Vermont-NEA, the state affiliate in Vermont of the National Education Association. As such, I represent 5,900 teachers and education support personnel, and, in so doing, I am unabashedly an advocate for public education in Vermont. I am also by profession a teacher of foreign languages.

That we have before us a particularly critical situation in math and science cannot be blinked. An entire litany exists regarding the current and projected shortage of qualified teachers in those disciplines; the hazardous practice of placing in such teaching positions teachers who are minimally qualified or indeed unqualified for those disciplines; the disparity in salary between education and industry; the lack of challenging student requirements in math and science at both the elementary and secondary levels.

Vermont is not atypical. In 1980, for instance, Vermont colleges graduated two science teachers and ten mathematics teachers; in 1981 we produced one science teacher and six mathematics teachers[1] — with no guarantee that these individuals would ever enter the classroom, much less stay there. In Vermont, as elsewhere, industry is very attractive when one compares the average beginning Vermont teacher salary of $10,373 with the $20,000 which can be earned in Vermont industry as a starting salary. Indeed, for us in Vermont, the salary aspect of the problem is exacerbated by Vermont teacher salaries being 49th[2] in the nation; not only Vermont industry but also education in other states tends to lure away qualified people.

In Vermont and nationwide, however, the "crisis" is much more broad-based than the math/science crisis which has caught the national interest. Every area of public education is in jeopardy. Low salaries and demoralizing working conditions have resulted in 36 percent of our teachers saying that they probably or certainly would not choose teaching again as a career[3]; in 1981, only two percent of college freshmen intended to become secondary school teachers and only 3.5 percent intended to become elementary school teachers.[4] In Vermont, in 1982, we had shortages not only in math and science, but also in business education, industrial arts, English, foreign languages, and reading.[5]

And again, there is more than the issue of "Do we have enough qualified teachers"; there are also the questions, "Are we asking enough of our children ... Are we providing enough"? Let us look for a moment at only the situation for foreign languages. I was a product of the era when funds generated by the National Defense Education Act were being infused into the public schools. I know from experience what a vibrant, healthy, more than minimal foreign language program is and how it can entice a student. I also know what it is to have struggled with increasing difficulty — from 1966 until 1981 — to provide such a program. I know what it is to have foreign language considered a "frill", to fight like a demon to maintain a five-year foreign language sequence, to see foreign language students actively "counseled" into other courses because those courses were more "valuable."

This may seem awfully simplistic — but if foreign languages were "good for us" in 1958, they are "good for us" now. Foreign languages are still basic to our ability to communicate with the rest of the world, to understand the other cultures of the world, and, hopefully, to coexist in peace. Nevertheless, foreign language study has been allowed to deteriorate so that we now face the appalling situation reflected in the study produced in 1979 by the President's Commission on Foreign Language and Area Studies. In the mid-1960's, nearly a quarter of all secondary students studied foreign languages and over a third of all colleges had admission standards requiring foreign languages. In this past decade, only 15 percent of all secondary students studied foreign languages and only eight percent of our colleges have maintained their admissions requirements for foreign languages. Furthermore, only four percent of our secondary school graduates are now studying a foreign language for more than two years.[6]

Too long missing on the local, state, and national scene has been a focusing — in a positive, productive way — on the needs of public education in this nation. That this inattention to the whole of public education has been foolhardy is unfortunately now "coming home to roost" — as the nation's economic and military and social health is unquestionably threatened as a result.

The President, it would appear, does not truly comprehend the magnitude of the problem. To initiate a remedy in only the math/science disciplines, he has suggested $50 million — with all due respect, a truly paltry sum in the face of the large scale problem; yet a sum large enough, if taken from the already undernourished Chapter II monies, to cripple even further education programs at the local level. The proposal would cure little if anything, while doing genuine harm.

It is logical then that Congress provide the needed national leadership, that Congress encourage a renaissance in public philosophical and financial support of education. I suggest that needed is a comprehensive program which does not focus on only two components of the education spectrum (i.e., math and science), a comprehensive program which minimizes bureaucratic entanglement while maximizing financial and operational benefit at the local level, a comprehensive program which has dollars attached which are equal to the problem being tackled. I suggest the American Defense Education Act (ADEA).

S.530, like H.1310, is obviously very well-intentioned and carefully crafted. It is a far better approach to the overall problem than is the President's proposal. I see S.530, however, as more of a "foundation" or "planning" piece of legislation which could be a precursor of or a component of ADEA. I see real problems operationally if S.530 alone were the solution. The 50 percent matching of funds from the state and/or local district could potentially result in worsening the "haves/have nots" syndrome and hence threaten both equal access and equal educational opportunity — two concepts which we in Vermont education have been striving valiantly to attain and maintain. ADEA, having no matching funds component, would not have the inherent possibility of "shutting someone out."

Another operational component which I believe would pose problems, particularly in a state such as Vermont, is the rigid structure imposed by the percentages for the various disciplines and for the various levels, all to be administered by the state.

Education in Vermont is very definitely interpreted as a "local concern" and resentment could all too easily erupt against "these federal and state regulations", the paperwork necessitated to "keep everything straight" being "more trouble than the money is worth." Local districts would be more able to assess their needs themselves and to address those needs themselves more effectively and efficiently if dealing directly with the source of the funds (i.e., the federal level) rather than through a "complicating middleman" (i.e., the state), and if not potentially "hamstrung", regardless of local needs, by the percentages imposed in S.530. ADEA would allow for unencumbered local solutions for local problems under local control.

And last but not least, a third troublesome component of S.530 is the amount of money attached to the legislation. $400 million is certainly a great deal of money. I believe, however, that the magnitude of the problem necessitates more dollars. If my computation skills serve me well, I estimate from $7 to $15 per student at the elementary/secondary levels from S.530. Granted, those additional dollars would be more than we have now, but they really do tend to pale when compared with the minimum of approximately $50 per student from ADEA. And that is discounting the potential doubling of those ADEA dollars if a local district presented substantial evidence of establishing and maintaining successful programs. ADEA would provide more "long-term remedy" dollars whereas I see S.530 as providing dollars which would be more "short-term", "emergency-oriented" in nature.

Lest you think it my contention that the federal government bears the entire or the largest burden in overcoming, hopefully once and for all, this lack of appropriate attention to public education and the attendant woeful results — I do not. I do firmly believe, however, that the federal government has the responsibility of setting an example in considering public education a high priority and that it has the responsibility of financially supporting education to its fair share, not leaving the states and the local districts staggering under a burden which they are in no way prepared to or able to bear.

A few responses which I believe to be appropriate from the state level, with or without support from the federal level.... A state should have in place and fund fully general state aid to education legislation which would serve to minimize disparities among local districts' ability to provide equal educational opportunity. (Vermont has not totally succeeded here, by any means, but we have progressed greatly in the last year.) A state should address itself to "pre-service" remedies — e.g., loans for undergraduates, which loans could be partially forgiven if the students then taught in that state. (Vermont has such a bill before its Legislature now.) A state should have money available to facilitate any needy student's attending college — regardless of career choice. (Last year, when it appeared that federal help was being further depleted, Vermont's Legislature further "beefed up" the Vermont Student Assistance Corporation.) And states should also address especially the early education years, those years which are the foundation for all that follows. (As you can see from the enclosed white paper on Governor Richard Snelling's Early Education Initiative, Vermont is in the process of doing just that — and when in place the program will address strengthening not just math and science, but also language arts, the arts, and health.) And certainly, states should not abrogate their responsibility to encourage more competitive salaries for teachers of all disciplines. If all teachers' salaries are not upgraded, our ability to attract and to retain qualified professionals will continue to be undermined as will our efforts to maintain quality education across the board.

Obviously, the local level has to "deliver" the actual program, has to be willing to support financially and philosophically its local schools — with, of course, adequate and appropriate support from the state and the federal levels. It would be ideal if local business and industry would facilitate such "delivery." It would certainly behoove their public interest and their self-interest to provide equipment, role models, guest lecturers and demonstrators, and perhaps even to participate in a type of community-based education program.

Unfortunately, the federal leadership, the emphasis on education nationwide,has not been what we have needed to evoke that needed response nationwide from the states or the local districts. The opportunity to exercise that leadership, effectively and efficiently, is now before you — I suggest in the form of ADEA. The need for such leadership has not been so great since 1958. Perhaps the need for courageous leadership is even greater now since there is no visible Sputnik to give impetus to curing our present illness. Our children, whether they consciously realize it or not, cry out for such courage and leadership and commitment on your part. And I firmly believe that, unless such courage and leadership and commitment are forthcoming, our nation as we know it — or rather as we would hope to know it — simply cannot and will not survive.

REFERENCES

1. From study published by the Vermont Department of Education's Adult Education Service (1981).

2. From NEA Research Memo: Estimates of School Statistics (1982-1983).

3. From NEA Research Memo: Status of the American Public School Teacher (1980-1981).

4. From Alexander W. Astin, The American Freshman: National Norms for Fall 1981.

5. From study on teacher supply and demand published by Vermont Department of Education (1982).

6. From Strength Through Wisdom: A Critique of U.S. Capability.

(Note: In the interest of economy, supplemental material accompanying this statement was retained in the files of the Committee.)

Senator STAFFORD. Thank you very much, Maida.

Dr. Brown, we would now be pleased to hear from you.

Ms. BROWN. Good afternoon, Mr. Chairman. I am Dr. Quincalee Brown, executive director of the American Association of University Women, an organization of 190,000 college-educated women founded 102 years ago to open the doors of higher education to women.

We are joined in our testimony today by the Association for Women In Science; the Federation of Organizations for Professional Women; the National Federation of Business and Professional Women's Clubs, Inc.; the National Institute for Women of Color; the Project on Equal Education Rights of the NOW Legal Defense and Education Fund; and the Women's Equity Action League—organizations who have similarly strong interests in assuring that women and minorities participate fully in math- and science-related fields.

The written testimony is extensive, and today I would like to highlight the three major sections of it briefly. First of all, the problems; second, the remedies; and third, the recommendations that we have.

The problems are familiar to all of us. We are aware of the underrepresentation of females in higher mathematics, physical sciences, and technical courses. We are also aware of the lower aspirations of women and minorities relating to their participating in careers requiring competence in these areas.

Department of Labor job projections notwithstanding, these fields are where the majority of jobs will be in the future. If current trends continue, women and minorities will not be filling these jobs in the future.

We are also aware of the lower scores that women and minorities have on such academic requirements as the Scholastic Aptitude Test where, on the average, females score 50 points lower than males, and on the Graduate Record Exam, where the male mean in mathematics is 563 and the female mean is 484.

In cases where other legislation has been in force for a few years, such as vocational education, there still is a lower participation of females in training for technical jobs. Only 19.8 percent of all people enrolled in technical vocational educational programs in 1979 were women, and of all women enrolled in vocational education schools in 1978, only 1.2 percent of them were in technical fields.

We know that these problems may not be attributed to any lack of talent or any genetic structure. We feel instead that it is due to a history of discouragement from parents, teachers, counselors, peers, and society, and a real scarcity of female-role models. After the sixth grade, there are very few teachers teaching higher mathematics; Mrs. Roberts is certainly an exception, and I am glad to see that.

Fathers, after the sixth grade, tend to help their children with math; mothers rarely do from that point on; advanced math is taught more often by men, and even in tests of female teachers, these women show less confidence in their ability to teach math and science than do their male peers.

These, then, are the problems that we are all familiar with and the ones we would like to see remedied. What are some of the remedies available to us? First of all, we know that there are already programs available in both good number and of high quality. Certainly they can be better used to address the problems that we now face in a significant fashion.

However, in the past the programs that are now available have been used sporadically at best, but evaluations show that where they have been used, there has been improvement both in female and minority participation.

My written testimony cites any number of these programs that are available, and we would encourage utilization and dissemination of these rather than costly recreation at the Federal level. We don't need to create new programs; we can replicate at the Federal, State, and local levels—the ones we already have.

A second remedy that we feel is crucial deals with the school system and the retraining of teachers. Because of the difference in educational experiences of males and females, we think it is important that the school officials, especially teachers, guidance counselors, and administrators be educated in the need and methods for removing the barriers to math and science to women and minorities.

Second, we need very specific training and retraining of teachers. This would solve two problems: First, it would help the oversupply of female teachers in the humanities, the arts and languages; second, it would help the shortage of math and science teachers. This training, however, has to be of the highest quality. Instructors must not only be competent and have a strong background in their fields; they must be good motivators, which means that they have to have enthusiasm for the field and that they also have to have a good sense of security in their own ability.

Also, we feel that there need to be improvements outside the educational system through parental influence and interactions with professionals in the mathematics and science fields.

Funds need to be set aside at the Federal, State, and local level to implement all of these programs. We believe that model programs and the awareness of their existence must be emphasized; that States must use funds to retrain teachers and increase the number of women and minority teachers in science.

There must be adequate data collection of the results of all of these efforts so that we can evaluate and reevaluate our progress and that scientific literacy for the total population must be encouraged. We do not need a scientifically illiterate population in general.

We also believe that we need more than 5-year stopgap measures to solve the long-range problem of too few females and minorities in advanced mathematics and science. There is a long-term need, and we must lay the groundwork here for a foundation for long-term solution.

This is not simply an issue of equity and fairness. Women and minorities are a majority of the work force, and we as a society need technically skilled and knowledgeable workers. If we are to maintain any semblance of economic survival in a high-tech society, both individually and socially, we cannot afford a scientifically illiterate population.

Senator **Stafford**. Thank you very much, Dr. Brown.

[The prepared statement of Dr. Brown follows:]

STATEMENT OF DR. QUINCALEE BROWN, EXECUTIVE DIRECTOR, AMERICAN ASSOCIATION OF UNIVERSITY WOMEN

Good afternoon, Mr. Chairman. I am Dr. Quincalee Brown, Executive Director of the American Association of University Women. AAUW, an organization of 190,000 college-educated women, was founded in 1881 to open the doors of education and to broaden the opportunities available to college-educated women. In light of our history in the forefront of concern for women and education, we are particularly pleased to be able to discuss with you some of the barriers that remain to females in math, science, technology-related, and foreign language academic courses and careers and some of our suggestions to remedy these problems. The AAUW is supported in this testimony by several other organizations who have similarly strong interests in assuring that women and minorities participate fully in math and science-related fields.

PRESENT CONCERNS

AAUW perceives problems centered around the underrepresentation of females in higher mathematics, physical sciences, and technological courses coupled with their lowered aspirations and participation in careers which require competence in these areas. Women make up 51.4% of our nation's population (1980 census) and 43.2% of our workforce (U.S. Dept. of Labor, 1982). We are all aware of the disparity in the economic status of females and males in our society: in 1981 women earned an average of only $0.59 for every $1.00 earned by men (U.S. Dept. of Labor, 1982). This figure has remained relatively unchanged for the last two decades. Some of this disparity can be accounted for by the types of jobs held by women and their comparative low percentage representation in mathematics, science, or technically-oriented employment.

For instance, a substantial percentage of this country's research money goes into defense related programs. Yet women and minorities, because of poor math and science preparation in pre-college and college years, do not benefit from the opportunities in these fields. Nor are they able to contribute their intelligence and creativity to a wide range of technically-based national security questions.

The Department of Labor has issued job projections for the decade of the 1980's (Carey, 1981) which indicate that the need for workers who have skills that require mathematical, scientific, and technological training will rise dramatically. Included in the list of the 20 most rapidly growing occupations are data processing, machine mechanics, computer systems analysts, computer operators, computer programmers and aero-astronautic engineers. Women currently are underrepresented in many of these occupations, for example, only three percent of engineers are women. The National Science Foundation (NSF) reports that in the past decade the number of bachelor's degrees in engineering earned by women has increased only from 350 (0.7%) in 1970 to 6,100 (10%) in 1980 (NSF 1982). The percentage of women earning doctorates in engineering is even lower compared to the number earned by men: in the academic year 1980/81, 1086 doctorates in engineering were granted to men and 42 were granted to women (National Research Council, 1982).

Many standardized test results in the United States indicate that the scores of females in mathematics are significantly lower than those of males. Results of the Mathematics Achievement subtest of the Scholastic Aptitude Test are consistently 50 points lower for females than for males. Verbal subtest scores are basically equivalent. Furthermore, when noting percentages of male and female students scoring over 600 on the Scholastic Aptitude Mathematics test, the contrast is again seen. Four percent of the males and one percent of the females score between 700 and 800, and sixteen percent of the males and eight percent of the females score between 600 and 699 (Gordon and Addison, in press). The Graduate Record Examination results show even greater disparity. The 1980/81 mean score on the Quantitative subtest for females is 484, contrasted with the mean score for males at 563 (Gordon and Addison, in press).

Most of these differences in achievement can be traced to a history of lower participation rates in advanced math courses and the minimal encouragement to take higher math that junior and senior high school girls hear from their parents, teachers, counselors and peers. The achievement levels are not in fact attributable, as has sometimes been stated,to a math gene possessed more often by males than females (Armstrong, 1979). According to a recent National Academy of Sciences Report ("Climbing the Academic Ladder," 1983):

> Sex differences in either mathematical performance or interest are not observed in young children but differences in expressed interest appear among academically highly able students in 7th or 8th grade, with boys much more interested in math. This greater interest appears to be closely linked to career interests in scientific fields (Haven, 1972). Other findings (Astin, 1968; Fox, 1981; Helson, 1971) support the conclusion that timely encouragement during adolescence is important in sustaining mathematical-related interests of girls and boys, but that girls are far less likely to receive it from any source.

Like academic education, occupational or vocational education and training in fields related to technology must be made fully accessible to women. Women comprise 46 percent of all students enrolled in vocational education (Foxx, 1981). Yet in 1979 only 19.8 percent of the individuals enrolled in technical vocational education programs were women (U.S. Dept. of Education, 1980). Still more indicative of the problem is the fact that in 1978 only 1.2 percent of all women in vocational education programs were in technical areas; and only 6.5 percent were in trade and industrial areas (Wells, 1981).

The 1976 Vocational Education Act Amendments made strides toward achieving equal access in vocational education programs; however, problems remain such as single sex occupational education institutions that exclude women by policy and practice; course restrictions by sex, usually implied by sex stereotyped course descriptions or brochures; and guidance and counseling practices that channel students into sex-stereotyped occupational training (Jobonaski, 1981).

SOCIOLOGICAL AND CULTURAL FACTORS RELATING TO THE UNDERREPRESENTATION OF FEMALES IN MATHEMATICS, SCIENCE AND TECHNOLOGY

The underrepresentation of females in educational courses and in occupations where mathematics and science applications are fundamental may be attributed in part to the scarcity of appropriate female role models in these fields. Studies show that after the sixth grade, fathers are more likely to help children with math homework than are mothers (Ernest, 1976); advanced math courses are most often taught by men (Fox, et al, 1977); and female elementary preservice teachers have lower estimates of their math abilities, and they openly admit that they are less comfortable teaching math than their male peers (Aiken, 1970).

PROGRAMS TO INCREASE THE PARTICIPATION OF FEMALES IN MATHEMATICS, SCIENCE, AND TECHNOLOGICAL COURSES AND OCCUPATIONS

During the past decade the growth in number and quality of programs designed to address the disparities between women and men in course selection and occupations requiring training in mathematics, science, and technology has been significant. The use of these programs, however, has been geographically sporadic even though evaluations have shown that many of these programs can significantly improve female expectations of their ability to succeed, especially in mathematics. Examples of these programs are:

EQUALS. A low-cost training program designed to provide practical assistance to teachers, counselors, and administrators, serving grades K-12, so they can promote the participation of females and minorities in mathematics. Evaluations have indicated that use of the Equals materials has produced modest improvements in student's attitudes towards mathematics, increased interest in mathematics-related fields, and increased participation in elective mathematics classes (Lawrence Hall of Science, University of California).

MULTIPLYING OPTIONS AND SUBTRACTING BIAS. A series of four video-tapes focused on decisions to take elective mathematics courses. This is an intervention program designed to eliminate sexism from mathematics education. The video-tapes are specifically designed for parents, secondary school students, teachers, and counselors to increase their knowledge about sex-related differences and to improve attitudes toward females as learners of mathematics (Fennema, National Council of Teachers of Mathematics, 1981).

WOMEN'S EDUCATIONAL EQUITY ACT materials. Several materials development efforts funded under WEEA have focused on mathematics and science. Prior to being published, these programs have been field-tested and evaluated. Examples of these programs, which are low-cost and easily attainable are:

Expanding Your Horizons in Science and Mathematics, which consists of two films and a booklet to help educators and parents encourage young women to consider careers in science and technology.

Count Me In: Educating Women for Science and Math, a 30 minute video-tape which can be used as the basis for classroom or workshop discussion about nontraditional career opportunities for women.

How High the Sky: How Far the Moon?, a book for grades K-12 which offers ideas for developing guidance programs and classroom activities to promote students' interest in science and math careers.

It's Her Future, a film with an accompanying fact book which helps parents encourage their daughters to explore nontraditional vocational education programs and careers.

New Pioneer: A Program to Expand Sex-Role Expectations in Elementary and Secondary Education emphasizes instructional techniques to help educators explore and broaden their own sex-role perceptions and those of students.

Connections: Women and Work and Skills for Good Jobs, a multi-media package for middle school students that includes a filmstrip, a gamebook, and a discussion guide.

SPACES: SOLVING PROBLEMS OF ACCESS TO CAREERS IN ENGINEERING AND SCIENCE

A collection of activities designed to stimulate students' thinking about scientific careers, develop problem solving skills, promote positive attitudes toward the study of mathematics, increase interest and knowledge about scientific work, strengthen spatial visualization skills, and introduce language and familiarity with mechanical tools. Preliminary evaluations indicated positive results with both girls and boys in grades three through ten (Lawrence Hall of Science, University of California).

ASSOCIATION MATERIALS. Several associations have developed and

> published materials addressing the underrepresentation of women in mathematics and science related fields. For example, the American Physical Society has developed a packet, "Wanted: More Women in Science and Technology" for use by junior and senior high school counselors in their work with female students.

The American Association of University Women urges that federal legislation actively encourage the full utilization of these and other excellent programs that have already been developed.

TEACHER TRAINING

Given that there are differentials in the educational experiences of boys and girls, any teacher training must include instructional methods and materials aimed at both removing barriers to achievement and increasing the participation of females, minorities, and other traditionally underrepresented groups in science, math, technology-related and foreign language education programs and careers. School administrators, school board members, guidance counselors and teachers all need basic awareness training about the special barriers women and girls encounter in math and science education. We recommend that the techniques and models already pioneered and proven in successful intervention programs be incorporated into all aspects of teacher training.

Teacher retraining is a short-term solution to two problems: an oversupply of English and humanities teachers and a shortage of math and science teachers. Retraining is essential, but it, like all other teacher training, should be thorough, intensive and of high quality. Teachers need to be motivators as well as instructors; they cannot motivate without a strong background in their fields. In addition, there should be an effort made to recruit part-time teachers, retired teachers and teachers who have left the teaching field and want to return for retraining and certification.

S. 530 does not and should not address the question of teachers' salaries. The American Association of University Women recognizes that all teacher salaries must be improved if we are to attract and keep many of the best teachers. However, this is a question that we must urge state and local governments to face. Federal legislation should not advocate a differential pay scale for teachers of different subjects. While science and math skills are in great demand at the moment, we cannot ignore the continuing need for individuals who can read and write, individuals for whom history serves as a guide into the future, and philospohy and art as a suggestion of a better quality of life.

INVOLVEMENT OF GROUPS OUTSIDE THE FORMAL EDUCATION SYSTEM

Many successful intervention programs, such as EQUALS, are located outside the formal educational system. Local programs that have already developed some solutions to the problem, particularly in the involvement of girls and women in math and science programs should be encouraged and supported.

Parents are a key group. Because parents have such a great influence on their children's career choices, it is critical that they are aware of the problem and, if possible, become involved in the solution. One of the purposes of local funds should be developing parent-school partnership programs.

Science museums can foster enthusiasm and interest as can cooperative programs that allow students and/or teachers to spend part of their time in the industry setting where they can see their academic work applied. Such programs should be mandated in federal legislation.

Interaction with professionals working in industry or academic research who can demonstrate the applicability of math and science skills has proven to be a motivation for all students. Programs established to increase access for underrepresented groups should take note of this proven method and bring women and minorities whose careers depend on their skills in math and science into classroom situations to give seminars and to teach specialized courses. These exchanges can spark students to identify with role models and perhaps make inquiries into subjects that they had either never thought of or dismissed as inappropriate.

RECOMMENDATIONS

We welcome the interest of the Congress in developing math/science legislation and commend the numerous Senators who have researched this topic and introduced their own legislation. Many of these bills contain specific ideas for development and implementation of math, science, technology and foreign language curriculum development, teacher training, and public participation which could be combined into an exemplary national program. The Education for Economic Security bill (S. 530) lays the foundation for such a composite piece of legislation.

There are several principles which should be incorporated into any math, science legislation. Increased participation of women and minorities as well as other traditionally underrepresented groups should be an integral part of all math-science legislation and the programs that it creates. We cannot afford to let 43% of our work force fall further behind at a time when increased productivity is essential to economic recovery.

As a means of accomplishing the full integration and participation of women, minorities and other traditionally underrepresented groups in math, science, technology and foreign language educational programs and careers, we recommended that funds be set aside at the federal, state and local levels to aid in the assessment, development, distribution, implementation and evaluation of programs designed for this purpose. Funds must be directed toward teacher training, curriculum development and public involvement. The general math and science deficiency that this country faces will not be remedied if we leave out any of these components.

- At both the federal and state levels, model programs, such as those described above, should be at least in part federally funded in their development, implementation, evaluation and distribution stages. Teachers, administrators, counselors, students, and parents should be made aware of the need for these programs, their availability, and their potential. Further, the usefulness of these programs should continue to be upgraded by ongoing evaluations of their use and impact.

- Local educational agencies should use a portion of the funds allotted them by formula to increase math and science access and achievement among women and minorities. All programs and materials administered or developed under this Act, whether at the local, state, or federal level should incorporate methods to reach full participation of females and minorities. Further funding of state and local level programs under this Act, should, in part, be made contingent on the degree of success the agency has in increasing female and minority participation.

- In order to fully assess our current situation and future progress, data collection should be required by federal legislation. These data will make possible regular reviews to determine if programs established under this Act are effective and in compliance with the intent of the law to attain the full participation of females and minorities in these fields.

- Teachers and students are not the only groups who need to be reeducated or educated, the entire population must become scientifically and technologically literate in order to support rapidly developing technology-dependent industries.

- Although we recognize that the legislation before us is emergency in nature, we believe it should be developed as more than a two to five year stop gap program. We should pay attention now to our long term needs, to the demands which we will face over the next several decades. Any legislation adopted by Congress in the next several months should provide the foundation of a long term, well-planned program. Only in this way will our technology-dependent economy begin to grow. Such a comprehensive approach will require a larger commitment of money than authorized by S. 530--money that we cannot affort not to spend.

CONCLUSION

The Education for Economic Security Act is a good start toward improving the quality of math and science education but much more needs to be done. We expect, also, that the funding level that is proposed for this legislation will not be sufficient to accomplish all that needs to be done.

Opening the door to math, science and technical careers to women and minorities is not simply an issue of fairness and equity. Women and minorities are the majority of our workforce. Unless we tap this pool of workers, shortages in skilled workers will only get more serious. To meet this challenge of science and technology, to stay abreast of developments elsewhere in this world, to maintain our leadership in this area, we have an obligation to prepare both our male and female students in mathematics, science, technology and foreign languages. We cannot afford a scientifically illiterate population in a high technology society.

Senator STAFFORD. And now, Ms. Cooper, we would be very happy to hear from you.

Ms. COOPER. Thank you, Senator.

I am very pleased to be here. I am Maudine R. Cooper, I am vice president of the Washington operations office of the National Urban League. I must say at the outset that I am awed to be in these surroundings——

Senator STAFFORD. Could you pull the mike up just a little closer so we can all hear. Thank you.

Ms. COOPER. My teaching experience has been limited to one course in business law, which I taught at a local State college, and Sunday school. And I have always been one who believed that teachers should have hazardous-duty pay, and if it possible for that to be an amendment to this legislation, I think that is appropriate.

Needless to say, for over 70 years now the issues which are being discussed here have been top priorities for us because of the undisputed link between education and opportunity. The National Urban League therefore believes that there ought to be opportunity-expanding in this high-tech area, and in these high-tech professions.

The League has become actively involved and supportive of the workable plan, of any workable plan, to bridge the job-market needs with job-market skills, which indeed is a major gap in our educational system today.

To capsulize our position on the proposals being considered today, let me say first that we are convinced that there is a strong need for Congress to act. We feel there are compelling issues regarding the lack of minority access to math and science programs and professions, and we have reservations about the proposal which has been approved on the other side of the aisle.

That proposal we feel is too broad for the limited funds it authorized, and we are therefore pleased to see the Senate take another approach.

Discouraging as today's figures and the picture of math and science curricula seem to be, the situation for blacks and other minorities in today's climate is particularly dismal. According to census figures to be published this month by the Department of Commerce, blacks account for only 5.1 percent of those employed in mathematics and computer-science fields. And only 5 percent of all chemistry-related occupations.

In engineering, one of the largest technical job markets, blacks account for only 2.4 percent of those employed.

Discrimination in employment practices, along with other social impediments, explains some of this underrepresentation, but not all of it. Blacks are excluded from the technological job market chiefly because of their underrepresentation in technology-related programs at the academic level.

In 4-year colleges and universities, for example, blacks account for only 4.9 percent of all mathematics undergraduate degrees, and only 2.9 percent of all degrees in engineering and physical sciences. More than 40 percent of all blacks in higher education attend 2 year community colleges where course curriculums seldom correspond to the requirements of a technical profession.

Of course, an integral part of this discussion is the subject of school finance. School finance issues have received increased attention in recent years because in a number of instances, State and Federal courts have concluded that the financial inequities which were found in many school finance systems denied equal educational opportunity to many of the States' citizens.

To the degree that poor minority students are segregated into low-income neighborhoods and school districts, schools financed through property taxes can never be expected to provide equal educational opportunities. Per pupil expenditures have been found in some cities to range from a low of $356 in a district with low property base to $594 in a wealthier community.

It should be of no surprise to any of us why the children subjected to an education that is underfinanced are not enrolling in physics or calculus. In too many instances, those courses simply aren't offered.

Aside from the discussion on local financing, Federal support at levels presently being considered—approximately $6 per student—cannot be expected to have more than a minimal impact. The problems with funding, therefore, will not be addressed by the solutions being considered; despite the limited funding potential, the important first step can be made by targeting assistance to areas of greatest need, triggering State and local commitments and providing incentives for greater private sector involvement.

The Federal role in bolstering our math and science curriculums should be that of a catalyst. Goals for any Federal program should thus be well-designed and well-focused. To insure that the money appropriated is spent effectively, the legislation approved by Congress should not become an educational catchall used by one school to offer a third-year French class and by another to buy its first microcomputer for 10 to 15 of its most academically elite.

Nor should the money appropriated to school districts be used solely or even predominantly on teacher contracts. At the crucial elementary level, for example, the problems are curriculum development expectations and followthrough, not contracts.

High-tech needs will be with us for years—for years and years to come—and before we start allocating dollars, a clear assessment of needs and priorities will be essential. Such an assessment, we feel, will emphasize the need to develop specific strategies for those most excluded from the high-tech revolution. For an economy that expects to be competitive, no one can, should, or must be left behind.

Thank you.

Senator STAFFORD. Thank you very much, Ms. Cooper.

I have a few questions that I would like to ask, in the first instance, to individual members of the panel, and then the panel generally.

My first questions I am going to direct to you, Maida, but others may respond if they wish. You mentioned in your testimony concern over the deterioration in foreign language study. At the secondary level, to what extent is the deterioration of foreign language study the result of a shortage of foreign language teachers and inadequate instructional material?

Ms. **Townsend**. I can't give you specific percentages, Senator, however both the shortage of foreign language teachers as well as having finances available at the local level to purchase appropriate materials play a definite role in that problem, in addition to the whole lack of support for foreign languages as an important part of the whole education of the whole student.

Senator **Stafford**. Just out of curiosity, which foreign languages do you teach?

Ms. **Townsend**. French. And I was also certified to teach Spanish, but did not have the opportunity to do so.

Senator **Stafford**. I see.

Do you feel that the greatest problems of economic security and defense, as they related to deficiencies in foreign language study lie in the deterioration of traditional language programs at the secondary level, or in the lack of attention to critical foreign languages such as Japanese and Russian at the postsecondary level?

Ms. **Townsend**. I would suggest that both of those play a role. Foreign languages, in their entirety, need to be supported more, as I mentioned in my testimony, both philosophically and financially. The whole concept needs to be understood again as it was back in the Sputnik era that foreign languages are basic to communicating with the rest of our cohabitors in this world, and understanding their cultures. Hence, where they are coming from philosophically when we are attempting to deal with them.

Senator **Stafford**. Thank you very much.

Dr. Brown, you note in your testimony that math and science legislation should contain a set-aside to increase the participation of women and minorities in math and science instruction. You also note that continued Federal funding of State and local math and science programs should be contingent on a degree of success in increasing women and minority participation.

What portion of the funds authorized under this act should be reserved for programs which work specifically to increase the participation rates of minorities and women?

Dr. **Brown**. AAUW and the groups joining us in this testimony would prefer that women and minorities, groups totaling over 60 percent of the population, not be forced to ask for set-asides. Our interests should be protected throughout the entire legislation. Participation figures, cited in our testimony, indicate that we must do more than simply mainstream women and minorities if we are to reach acceptable participation rates. Past experience has shown that if groups are not forced to implement changes in their programs and given the funds to accomplish this, changes simply do not occur. Therefore, to elaborate on my testimony, we support: A Federal program funded at a minimum $10 million a year for developing, reviewing and disseminating model programs and curriculums aimed at expanding the participation of women and minorities; States should be required to spend 10 percent of their share of Federal funds for model, exemplary, or statewide programs to expand the participation of women, minorities and underrepresented groups in mathematics, science and technical education programs and careers, and for competitive incentive grants to local school districts that want to make increasing the participation of underrepresented groups a priority; all State and local programs receiving Federal funds aimed at improving mathematics, science and technical education must build in efforts to increase the participation of traditionally underrepresented groups. This includes both teacher training and classroom curriculum materials.

Evaluation all along the way has to play a role in whether or not the programs are refunded or whether they need to be improved before refunding.

Senator STAFFORD. Do you have any mechanisms in mind that we could use to measure increased participation for women and minorities in math and science, and how should funding for math and science be specifically tied to such a proposal? Do you have such in mind?

Ms. BROWN. Certainly there are ways that you can measure. You can look at female and male and minority participation in a school system, look at the percentage of students that are participating in higher math and science courses, and look at what proportion of those are females; what proportion of those are minorities. Achieving full participation would mean bringing the female and minority math and science classroom participation level up to the level of their representation in the total student body of a given school.

The second part of your question dealt with the funding for that.

Senator STAFFORD. The second part of my question was, how should such funding for math and science be specifically tied to any mechanism.

Dr. BROWN. Certainly I think there can be Federal standards set that are applicable then to any school district and that funding could be tied to whether or not those standards are met within a reasonable amount of time. That might take some pretesting in selected districts, and refining of formulas, but it is certainly possible to tie continued funding to how well the participation occurs.

Senator STAFFORD. Thank you.

Ms. Cooper, do you care to respond to those two questions?

Ms. COOPER. Just briefly, on the set-aside notion. Set-asides are not intended, I believe, to be the absolute end in terms of access by minorities and women. What set-asides do generally is to begin to sensitize those who are charged with the responsibility of allocating and receiving those dollars to make sure that they understand the need and what is being omitted from their local processes.

I don't think that the numbers or the percentages are as critical as the notion that from the Federal level, we have to talk about mandating some action on the part of those who are very reluctant to change, those who do not see this as a key issue, and those who simply do not want to address the problem head on.

In addition, we've found that when we use set-asides in other program areas, that those who have them as a responsibility say they like them because politically it allows them to do what may be locally unpolitically popular. And so there's a kind of assistance from the Fed in terms of letting them do what the local population might be up in arms about.

Senator STAFFORD. Thank you very much.

Now a question to the panel generally. One of the arguments for a Federal role in mathematics and science education is the crisis we face in providing Americans with the technological skills necessary to meet our economic and defense needs. Most existing Federal education programs provide aid in emergency situations or to special populations, rather than general aid or aid for specific subject areas.

First, do you believe that the allocation of math and science funds should contain a factor which accounts for the numbers of people classified as members of the special population. And second, to what extent should the Federal Government target math and science money to States, institutions of higher education, or local education agencies with the most severe math and science deficiencies?

How would you best measure math and science deficiencies? It is sort of a triple-barreled question, isn't it. Do you want to address the first part of it first? The first part would be, do you believe that the allocation of math and science funds should contain a factor which accounts for the numbers of people classified as members of a special population. Does anyone care to comment?

Ms. COOPER. Well, that goes somewhat to the notion of set-asides, but I think—and this is based on a noneducator's experience—as we read the newspapers and other journals and so on, they talk about the fact that youngsters in elementary school have the greatest ability to begin to get in and to learn math, science, and even to learn foreign languages.

Somehow we don't seem to concentrate on that. And it seems to me that if there is a realistic program developed for those elementary and secondary educational students, that they will begin to, as they say, rise to the top in terms of abilities and skills and easily identify. And I frankly believe that if that is done across the board, then the notion of special groups will begin to, I think, dissipate.

I think if women are allowed an opportunity at the elementary level, they will become the persons who entered the trade, math and science curriculum at the upper educational levels. The same is true of other minority groups.

But as long as they are being factored out or steered into the human sciences areas or social sciences areas, that that will not happen. And no amount of set-asides will stop that until we begin to concentrate on the elementary and secondary levels.

Senator STAFFORD. Anybody else wish to comment?

Dr. BROWN. I'm inclined to agree with Ms. Cooper. I mentioned very briefly the stereotyping that has gone on for centuries—that negatively affects career opportunities for women in math and science. As I know, growing up in the fifties, I certainly grew up with it myself. So that I am now faced with the situation of having to overcome "math anxiety," "technology anxiety."

If you just factor those out of population, out of a child's experience very early on, those that have natural ability will rise to the top no matter what kind of a group they belong to; male, female or any minority group.

Senator STAFFORD. Any further comment?

Maida?

Ms. TOWNSEND. I would agree wholeheartedly with the comments which have been made, and it goes to the heart of the overall problem, the need to support an improved education across the board, and not to focus on one aspect of education only, perhaps to a very genuine detriment of another.

Senator **Stafford**. Ms. Roberts, do you agree with the other witnesses?

Ms. **Roberts**. I certainly do.

Senator **Stafford**. It's nice to have unanimity in the panel.

The second question was, to what extent should the Federal Government target math and science moneys to States, institutes of higher learning, or local education agencies with the most severe math and science deficiencies? I think that may have touched on it, but I will put that to you, if any of you care to comment.

Dr. **Brown**. I prefer to leave that to other experts.

Senator **Stafford**. So say you all?

Ms. **Townsend**. I don't know if I qualify as an expert, or not—however——

Senator **Stafford**. That never deters anybody down here. [Laughter.]

Ms. **Townsend**. Then I certainly won't let it deter me, either. I would suggest that if at the local level where people who are directly dealing with the needs of the children can best identify and analyze what needs to be done, and that they would then use the dollars available to meet those needs.

And this does not relate specifically to your question, Senator, since you have highlighted strictly math and science, but I would have to reiterate the importance of the broad spectrum of education and in particular the early education years.

Senator **Stafford**. Thank you very much.

Dr. Brown?

Dr. **Brown**. I had better recant what I said. While I agree totally with what Ms. Townsend said, I also think we have to be aware of what Ms. Cooper said. At times, States and localities don't want to implement some programs to eliminate discrimination in the ways that they need to be implemented. Certain set-asides and certain requirements remain very important means of enforcing Federal standards.

Senator **Stafford**. Thank you very much, all of you.

Senator Pell?

Senator **Pell**. Thank you very much, Mr. Chairman.

One of you I remember mentioned Sputnik and the galvanizing effect that had on us. And I happened to be in Moscow when it was announced; I remember the galvanizing effect it had on the usually lethargic Russians; they were buzzing around and jumping around in the streets. Maybe what we need is another Sputnik, but I hope not.

A couple of questions here. First, Ms. Roberts, with regard to time-sharing. Two teachers sharing a year or alternating years; that means that they have one salary, but split the time they use so that each of them would get a half salary?

Ms. **Roberts**. Yes, except that it might be very unlikely that two teachers would be on exactly the same salary pay. Let's say that one teacher taught in this first semester of a course and received what would be his or her salary; based on years' experience, education, and so forth. When the second semester teacher took over the course, the salary would be adjusted to what——

Senator **Pell**. But each would get half their regular salary?

Ms. **Roberts**. It would be half of a regular salary. That would give teachers, for instance, if they were interested in an educational program, an opportunity to alternate working on an advance degree and teaching.

Senator **Pell**. Thank you very much.

Ms. Townsend, in your very helpful and specific comments on S. 530, you mentioned one, the difficulties about the matching, but actually that matching can be in kind and also, as you know, on a statewide basis. So in the end I don't think it would prove a burden to local communities, although there obviously is one more obstacle. But it could be overcome.

I think also we have to measure what is politically acceptable in getting a bill through. It is not always what the optimum is; it is what is acceptable.

Ms. **Townsend**. Yes, I understand those political realities.

Senator **Pell**. Another point you mentioned was the operational component, or the rigid structure imposed by the percentages of the various disciplines in order to be administered by the State. Some of the criticism we have got is that this bill is too general in its approach.

Is it your thought that there should not be, for example, a specific allocation for local education programs in math and science and computer learning and instruction, but that should be left to the State and the local communities?

Ms. **Townsend**. The aspect to which I was referring was that, for instance, only—strictly 65 percent, I believe, goes to elementary—secondary gets——

Senator **Pell**. That's right, 35 percent——

Ms. **Townsend**. And then within that 65 percent, it is delineated further by percentages as to how much is used for path or foreign languages or whatever.

I would suggest that it might be more beneficial to the students and hence to the Nation long term if there were more leeway, more flexibility there because in one district it might not be that percentage which particularly matches the, both the identified need in a given subject matter area, whereas in another district perhaps that percentage might work ideally, whereas in another, some other percentage would work better.

Senator **Pell**. I think the percentages are on a statewide basis, not on a local basis. So we have a certain amount of leeway on a statewide basis.

Ms. **Townsend**. I understand that. I still have difficulty with the impact that that might or might not have at the local level in really addressing the needs as identified at the local level. I think it will help in understanding where I'm coming from in Vermont—well, the people at the local level are doggone touchy about local control over education, and you might have more negative reaction, totally unsought, and perhaps even unjustified, if they sense that once again there was what they perceived as the heavy-handed approach from on high, if you will, telling them what their needs were when they could see at the local level, that those needs were somewhat different.

Senator **Pell**. I see what you are saying. I think a little bit earlier you emphasized the point that the local authorities, education authorities, really know the needs of the children better than anybody at the State level or the Washington level.

I would agree with you on that, but I wonder if, when it comes to knowing what the opportunities for those children will be, if that is not more visible on the higher level as to which way we're going; the needs of high technology and what industry will be like in the future, are matters on which the people in one of our mutual towns at home may not have quite the same range of views and information as to the opportunities those children will have in future years as might be available on a national basis.

Ms. **Townsend**. I appreciate your remarks and I am sensitive to them, and I might suggest that perhaps there would be a role to play by the State department of education, perhaps in the States, serving as resource persons, individuals to help in analyzing what the needs are truly, and what might be appropriate response to those needs, as opposed to people working potentially in a vacuum, which is certainly not what one would want to see.

Senator **Pell**. Thank you for that.

Now, most of you mentioned that $400 million you thought was too little. Well, I would agree with you, but again it is a question of the politically possible, and as you know even with an authorization if we get it through, the actual appropriation will be less; the authorization is the ceiling, the appropriation is what you work on on the floor.

It is a question of first having this bill and this approach take hold and then watering it as the years go along.

One other question in connection with the foreign language instruction. Do you think there is enough emphasis, Ms. Townsend, on the foreign languages in S. 530?

Ms. **Townsend**. I'm sorry, I didn't hear the last part.

Senator **Pell**. Do you think there is enough emphasis, or would you change the foreign language component of S. 530 in any way.

Ms. **Townsend**. If S. 530 were to remain precisely with all of those other—with the percentages in there as they are, yes, I would.

Senator **Pell**. In what way would you change them?

Ms. **Townsend**. I do not feel it appropriate right at this point in time for me to suggest a specific percentage. And I think I am getting into part of the problem I have with the percentages overall. But, was it 10 percent or 15 percent of the 65 percent that went for foreign languages? I have forgotten, to tell you the truth.

Senator **Pell**. It was 9.75.

Ms. **Townsend**. Percent. OK.

Senator **Pell**. I agree with you; I think we ought to get away from 9.75. I think 10 percent is easier to deal with.

Ms. **Townsend**. Yes. I see problems in administrating this, quite frankly. But from a personal standpoint and also from a professional standpoint, how foreign languages can be considered any less important than the other disciplines, I simply cannot see it.

Senator **Pell**. Good. Thank you very much for being with us.

Senator **Stafford**. Thank you very much, Claiborne, and on behalf of the full subcommittee, may I express our gratitude to all of you for helping us today with this problem we are addressing this year. We are very grateful.

Senator **Pell**. Mr. Chairman, I would like to take this opportunity to thank you for permitting me to chair the meeting in Rhode Island and particularly thank you for sending Mr. Skip Vallee of your staff to represent you at the hearing; he is very able.

Senator **Stafford**. I am glad to hear it, and I appreciate the kind words.

The Chair would now invite panel 2 to come to the witness table.

Dr. Roger Nichols, director, Museum of Science, Boston, Mass.; Mr. Stephen Salyer, vice president for Educational Services, WNET-TV, New York, N.Y.; and Dr. David A. Hamburg, president, Carnegie Corp. of New York, also of New York.

Gentlemen, we always feel a little twinge of guilt when we have to ask you to, knowing the effort you have made to be here and the time you have devoted to these presentations, to have to ask you to do it in 5 minutes, your full statements will be placed in the record as if read, and we would remind you of our stop and go light system that has been installed that gives you 4 minutes on the green and 1 on the yellow.

Having said that, I think I will start again on the—do you have some preferred order of precedence?

In that case, Dr. Hamburg, we might start with you.

STATEMENT OF DR. DAVID A HAMBURG, PRESIDENT, CARNEGIE CORP. OF NEW YORK, NEW YORK, N.Y.; DR. ROGER NICHOLS, DIRECTOR, MUSEUM OF SCIENCE, BOSTON, MASS.; AND STEPHEN SALYER, VICE PRESIDENT AND DIRECTOR, EDUCATION DIVISION, WNET-TV, NEW YORK, N.Y.

Dr. **Hamburg**. I congratulate both of you for the leadership you are providing in this crucial matter; I think it gives the Nation a sense of encouragement; some vision of a better future.

We live in a really revolutionary time. There has been more technological and social change in this century than in all the centuries put together before now. My parents, in their lifetime, saw the Wright Brothers on the sands of Kitty Hawk and Neil Armstrong walking on the Moon. It is almost inconceivable how much technological change there has been; that has brought about some paradoxes of success, like our aging population. We live longer and in many ways better than we did before, but as a side effect, that poses economic, medical, and social problems.

So it is really a very recent world that science and technology has shaped for us. Something like three-quarters of the scientists who have ever lived are alive today. So we are now trying to adapt to an extraordinary set of new developments. That is what I mean by revolutionary times.

The main social institutions we have for adapting to these drastically new circumstances are those institutions that can educate us; not only the schools, but the media and other institutions may help us to learn how to adapt to the world we have made.

There is at the moment, as I am sure you have heard time and again, a great disparity between the skills now being provided and what will be needed in the world of the future. This affects our competitive situation for the economy as the fulfillment of the human potential in our country.

That is why, Mr. Chairman, on the second of February, I, together with Governor Hunt of North Carolina, convened a group of leaders across a wide range of American society. Fifty some people met at the Carnegie Corp. in New York; leaders of science and business and labor and education, government, the foundation. We were all on 3 or 4 weeks' notice. I think that reflects the depth of concern in national leadership across the board; it is not at all a partisan matter.

And our meeting was very broadly conceived in both public and private sectors. One thing we wanted to do was to look at the array of initiatives now taking place in this field; in the past year we have had a rediscovery of the importance of education and its link to the economy. And then we wanted to see whether the time might be right to begin to move toward a national educational policy that could bring some coherence out of the current situation.

It is natural that we should do that because in our case, going back to the turn of the century, Andrew Carnegie had a deep passion for education, reflected, for example, in the more than 2,500 libraries that he caused to be built, and our foundation has a deep commitment to the development of human resources.

We recognize that we are in a new context now. The rapidity of these technological and social changes puts a challenge to us as we have not had for a long time to reassess our national priorities.

Participants in this meeting worked at some broad consensus, and following deliberation after the meeting arrived at a statement of guidelines for Federal legislation which I would like to convey to you briefly. I am here for that purpose, and it is a privilege to represent such a group. There were, for instance, seven governors who signed this statement. A few of the people, to give you some notion of the breadth of the group, were:

Lewis Branscomb of IBM; William Cary of the American Association for the Advancement of Science; Richard Cyert of Carnegie-Mellon University; Thomas Donahue of the AFL-CIO; Governor Dukakis; Governor du Pont; David Gardner of the University of Utah; Fred Hechinger of the New York Times; Governor Lamm; Richard Lyman of the Rockefeller Foundation; Jack Peltason of the American Council on Education; Frank Press, the National Academy of Sciences; Robert Rosenzweig, the Association of American Universities; Cecily Selby, the co-chair of the National Science Board Commission on this subect; Albert Shanker of the United Federation of Teachers; Raymond Stata of Analog Devices; Senator Tsongas; Dr. Vagelos of Merck Sharp & Dohme; Glen Watts, the Communications Workers of America; Clifton Wharton of the State University of New York; Governor Winter; William Norris, Control Data; Franklin Thomas, the Ford Foundation; Governor Cuomo; Senator Moynihan; and so on.

The point is that a very broad cross section of the American leadership from different sectors came togther on short notice and agreed on a set of general but I hope useful concepts providing Federal legislation. We are not commenting on specific legislation; we haven't gotten into that.

Let me very briefly read a few of the highlights of the whole statement, and then I will stop.

The first point is that Federal legislation, in our view, should serve two major purposes; improvement in mathematical and scientific literacy for the general population and also development of high-level skills, including foreign language skills, among the most talented.

Second, that we would include three levels of education in a comprehensive approach: schools, colleges, and adult retraining. I think concentration on any one segment alone would be insufficient and that the most immediate payoff comes with the retraining of adult workers, which has not had much discussion in the recent discourse as some of the other components of the problem.

The third point is to build on State and local initiatives; kind of bottom-up approach. We recognize that the primary commitment over the years and the primary support, overwhelmingly, is at the State and local level. Yet, and I should have said this at the outset, Mr. Chairman, we do feel very strongly that it is a national problem. It is much too large and complex not to have a very significant Federal role, even though we are advocating that that Federal role build on the initiatives that are very encouraging in so many of the States at the present time.

Fourth, we encourage partnerships among business, labor, education, and government. In many States, this collaboration is already taking place and we ought to build on the experience of the more successful States in that regard.

Fifth, we support both good programs that are already in operation; we don't have to reinvent the wheel; a lot of good things are being done that need to be scaled up; we also need to support new programs aimed at reform. Not all of the good ideas have yet occurred. We do think there is a special Federal responsibility to encourage innovation and to disseminate the results of evaluation so that we can all learn from each other as rapidly as possible.

Sixth, we emphasize talent development among minorities and women. As you have already heard this afternoon, it is not only an equity matter; we are dealing with a smaller group of young people who will be required to carry a more complex work burden in the decades ahead than we have ever had before. And in 10 years, there will be 20 percent fewer college-age students entering the work force, and by the year 2000, upward of 30 percent of these young people will be black or Hispanic.

The Nation will need all the black and Hispanic and women doctors, engineers, scientists, science-based professionals that we can educate.

Seventh, we should enlist the best scientific minds of the Nation to work on school and college curriculum projects as well as teacher training. I would add with special emphasis from my own experience a great deal of weight to this point; we have undoubtedly the world's largest scientific community; and I think it is not chauvinistic to say we have the world's most respected scientific community.

We have conditions of political and economic freedom that are especially beneficial for science. We must find—and here I think the Federal Government can help—ways to link strongly that scientific community, in universities and in the corporate laboratories, with the public secondary schools of our Nation. That seems to be a critical linkage.

Eighth, we should recognize the dignity and worth of school and college teachers. Improvement of the status of teachers is a crucial, long-term objective that is essential for enhanced opportunities that we envision for our students and our Nation in the future.

Ninth, we should provide incentives to leverage and encourage State, local, and private investment in education using such devices as matching funds, tax incentives, or loan programs, as well as targeted Federal funds which will be necessary to insure that underserved areas and populations are also taken into account in this new wave of educational progress.

In addition, we think that existing Federal departments and agencies should be encouraged to look at what they are now doing in terms of making a contribution. For example, the Department of Defense is making some contribution and could make more toward the education for the technical world that is such a crucial underpinning for national security. That is only an example; there are others that come to mind.

Tenth, it is important to build in a sustained Federal role. It is a long-term problem that will not respond to quick fix. The precedent of the 120-year-old Land Grant Act shows very clearly that a wise act of public policy in the educational field can have very practical results over the long pull. But it does take a long pull.

Now in closing, I want to emphasize a point of crucial significance with which I started, namely, that this is a truly revolutionary time in science and technology, and therefore it must be in education as well.

The very rapid acceleration of technological and social change in the past few decades sharply heightens the importance of our educational institutions. They really are more important to the future of our Nation than they have ever been.

And there are some key questions that we have to address in the next few years, and I am going to state them very briefly; I think each one is important.

First. How can we give all our children, regardless of social background, a good opportunity to participate in the modern technical world?

Second. What constitutes a decent minimum of literacy in science and technology that should be a part of everybody's educational heritage?

Third. Given the rapidity of sociotechnical change, how can we make lifelong learning—and I really do mean lifelong—a reality so people can adjust their knowledge and skill from time to time as circumstances change.

Fourth. Since educational institutions will more than ever have to hit a moving target—we all know how difficult it is to hit a moving target—we have to think more about preparing for change itself.

Fifth. How can we enlarge the talent pool of promising people for science-based careers regardless of their social background?

Sixth. And another point that I would want to emphasize strongly from my own experience, how can we broaden the spectrum of the sciences, say beyond math and physics, to make modern education increasingly informative with respect to the human experience? The importance of the life sciences, broadly conceived, has to be given due weight in these educational reforms.

Seventh. How can the educational system foster a scientific attitude useful in problem-solving throughout the society, one that relates scientific principles to the major issues on which an informed citizenry must decide? Almost all of our issues now have a high technical content, and if we really are serious about a democratic society, our citizens have to be in a position to make informed judgments.

And finally, the point that includes the foreign language matters you have heard about, but I would say goes beyond that: How can we achieve an informed worldwide perspective, a worldwide perspective in an era of profound economic interdependence and unprecedented issues of international security?

Well, these are formidable problems; they are not for a day or a month, or a year. But no people anywhere have ever had the opportunities we have now to address these problems. Short-term adjustments just won't be feasible; will not be sufficient. An obese person gets very little, if any benefit from a crash diet, but requires instead a permanent change in eating habits. So, too, we require long-term improvements in education over a wide front, if we are really going to fulfill the promise of this country in the 21st century.

Thank you.

[The prepared statement of Dr. Hamburg follows:]

STATEMENT OF DAVID A. HAMBURG, M.D., PRESIDENT, CARNEGIE CORP. OF NEW YORK

It is difficult to comprehend the truly remarkable changes that Americans have witnessed in this century as a result of the stellar advances in science and technology--from the Wright brothers on the sands of Kitty Hawk to Neil Armstrong kicking up moondust in less than a lifetime. The effects of mankind's achievements in all the sciences are now so pervasive that we sometimes forget the sociocultural changes that have accompanied them.

The current high-technology revolution, too, has profound sociocultural implications. We need only look into the future a very short distance to see that the revolution will be whirling a great number of people out of its vortex. These are people who will be inadequately prepared to work--and to live--in a technology-based society. The principal social institution charged with addressing this problem is the educational system, in all its diversity.

There is a widening gap between the training people receive in the educational system and the skills needed for the jobs of the future. This disparity is a major threat to our future national economy. The nation's productivity and ability to compete in world markets are jeopordized. Beyond these concerns is the more fundamental human concern for people who live on the periphery of society.

Other nations are embarking on carefully planned efforts to meet the demands of a high-technology future. These nations are designing their economic policies and educational programs to support promising high-technology industries--electronics, computers, communications, aerospace, biotechnology, new materials, energy.

Certainly one of the keys to our response is held by our educational system. Such challenges have been met in the past. In 1862 Congress passed the Morrill Act to establish the Land Grant College System. These schools specialized in education for agriculture and the mechanical arts and were a direct response to the changes of an industrializing society. After the Soviet Union launched the first Sputnik in 1957, a massive effort was made to equip schools for the teaching of science in the name of national security. Now the educational system is again being tested for its response to technologic change.

On February 2, 1983, a conference of leaders in government, business, labor, science, and education was convened at the Carnegie Corporation of New York, in order to discuss the educational needs of a high technology economy. This meeting was organized jointly by Governor Hunt of North Carolina and myself. Many of the participants are involved in cutting-edge educational research projects, innovative demonstrations, and leadership roles at the federal, state, or local level.

One purpose of the conference was to convey the diversity of these activities and to strengthen networks of communication among those involved. A second purpose was to determine whether this especially knowledgeable group believes the time is right tc attempt to develop a coherent national education policy linked to goals for economic development.

The Carnegie Corporation throughout its history has had a keen interest in education. Andrew Carnegie himself had a passion for education in all of its forms. The foundation has a long-standing interest in human resources--as the most vital of all national resources. We recognize that these interests must be placed in a new context, created by exceedingly rapid technological changes and their unprecedented impact on all of our social institutions. Because of these changes, now is a good time for reassessing national priorities for education and human resources.

Technological change is one of the central facts of our time. Since the Industrial Revolution, this change has been unabated; there was a technological spurt between 1870 and 1900, then again after World War II. The momentum of technological advances since 1945 actually seems to be accelerating. This puts a great burden on and, in principle, gives multiple opportunities to, our educational system--not only to train the workforce for a technology-based society, but to prepare people to live in a rapidly changing world.

The sciences and technology pervade every aspect of society. For example, in the next 20 to 30 years, biotechnology not only will change the way medicine is practiced, but also will affect agriculture, industrial processes, environmental safety, and many other fields. These are only the applications of biotechnology that are now immediately apparent. However, scientific progress does not guarantee human progress: the great leaps in knowledge in the physical sciences that have made possible our new information and communications technology have also produced nuclear weapons. We have to learn how--and to teach others how--to anticipate and handle the "side effects" that new technologies inevitably bring.

Our educational system must teach people to cope with accelerating rates of change and the growing complexity of social organizations. We do not yet know what is adequate preparation in the educational system, and in the family, for the conditions of the future society--living in it, effectively contributing and adapting to it, and even improving it.

If we expect the educational system to respond, we must devise a response that utilizes the full range of educational media--including the mass media--and serves all age groups, with special emphasis on a good start, so that later opportunities do not evaporate.

A program is needed that aims at two groups in the population: those who are going to pursue scientific and technical careers, and everyone else. For the latter group, the central issue can be described as the need for a "new literacy"--literacy in an upgraded and broader sense. Everyone will need a decent minimum of literacy in science and technology for employment, for functioning in daily tasks, and for participating responsibly in the democratic decisions of society concerning the uses of technology.

Future scientists, engineers, and other science-based professionals are the highly significant minority who will create and apply new and useful aspects of science and technology. For them, high quality training is essential. They contribute to our economic, military, scientific, and social well being, and help determine the way in which we are viewed in the world. A healthy scientific establishment is vital to the nation in any broad view of national security. The spiritual freedom--the freedom of inquiry and information--of a democratic society is a fundamental asset for the advancement of science.

Because first-rate scientific talent is rare, we need a large pool to draw from. In light of current low birth rates, the United States will have a smaller cohort of young people in the near future. Therefore, we must cultivate scientific talent in all segments of U.S. society, especially among those groups that have been neglected in the past. Some of our future scientific leadership may also come from immigration, just as in previous generations.

Progress in achieving scientific literacy for all and developing future scientific leaders depends on the health of our educational institutions. The training of scientists will require the involvement of certain key research-intensive universities. But they must draw on strength. Establishing a national network of urban and regional secondary schools that are strong in science is a major challenge to education. Another is fostering "soft" attributes that are highly pertinent to an effective economy, such as entrepreneurial skills, competence in communicating across multidisciplinary barriers, or understanding how to work within organizational structures. The educational system will almost certainly need major reforms. It may prove possible to develop new linkages--for example between science - rich universities or corporate laboratories and science-poor secondary schools; and to construct educational, professional, and research incentives for science teachers. .

Further, we need institutional mechanisms for analyzing the complex relations between education, science and technology and the economy of the future. Some of the institutions that can anticipate likely developments and help the nation respond effectively are the National Academy of Sciences, the American Association for the Advancement of Science, research universities, foundations, agencies of the federal government that are strong in science, and scientific and professional societies.

Industry's concern about the educational system is growing, and the solutions taking shape are not just the familiar on-the job training, but also intensive development of key people--such as engineers who are being trained in high-technology industries. Industry is recognizing that personnel will need periodic upgrading of their skills throughout their careers. This involves understanding of "career trajectories," designing variations on the sabbatical theme, and experimenting with many other approaches. Industry is also making commitments to early science training. For example, SOHIO has just made a large contribution to the American Association for the Advancement of Science to foster science education at the secondary education level. Industry's long-range commitment to social purposes of this kind is inherently valuable; moreover, it can have a constructive impact on government at all levels.

Traditionally, local and state governments have played a predominant role in education, and this needs to be strengthened now. The leadership of many governors is heartening. But the current shortfall will be expensive to redress. To do so in any enduring way will require substantial federal support.

This broad array of problems will require conceptual, financial, and organizational creativity. Although the general nature of the challenge and the response is clear, the details are not. The lack of a national strategy for support of science education leaves open the important question of responsibility. Essentially, education must have a higher place on the American agenda; it must be built on a broader base of all the sciences--not just math and physics--without neglecting the humanities; and we must be prepared for continuing changes as science provides a broad base for technological innovation which in turn requires social adaptation--not least in education.

Education cannot be confined to schools or to "school-years." This is especially pertinent to our present problems of unemployment. The public education system is not designed to reflect either lifelong goals or the multiplicity of educational resources.

We must utilize the full diversity of institutions providing education--corporations, churches, the mass media, the military. These various strands need to be brought together in a coordinated, cohesive effort, aimed not only at the school system. Thus, it is unlikely that we as a nation can greatly improve science education without addressing the broader context of education.

The participants in our February meeting--a wide range of leaders in industry, science, education, labor and foundations--agreed on a set of fundamental considerations. I state them here briefly. (The names of those endorsing the guidelines are attached at the end.)

Better education for economic growth requires action at all levels of government--local, state, federal--and in the private sector. The argument for federal action is that there is a pressing national need that the states and the private sector cannot meet alone. Moreover, with a mobile population and an increasingly specialized economy the benefits of education accrue to the nation as a whole and not to just any one state or locality. We think that federal legislation ought to reflect the following general guidelines:

1. Serve two major purposes: Improvement in mathematical and scientific literacy for the general population and development of high-level skills, including foreign language skills, among the most talented.

A crash program to produce more scientists and engineers without attention to the general population is shortsighted. General scientific literacy for citizenship is just as important to the future of the nation as the production of high-level experts. But concentration on the former to the neglect of the latter would also be a mistake. The nation badly needs highly trained and talented scientists, engineers, technical personnel, and persons skilled in foreign languages essential for economic growth as well as diplomacy and world understanding. Both purposes must be served.

2. Include three levels of education in a comprehensive approach: schools, colleges, and adult retraining.

Education for the new economy requires attention to both today's and tomorrow's workers in a systemic approach to improvement. The most immediate payoff comes with the retraining of adult workers. Mid-term effects come with changes in higher education. School improvement shows results over the long term. Concentration on any segment alone is insufficient.

3. Build on state and local initiatives.

Many states have clearly taken the lead in the arena of education and economic growth. Federal legislation should recognize state and local leadership and encourage a bottom-up approach to program priorities. Local and regional needs vary. Federal accountability requirements should emphasize clear statements of goals, targets, and easily documented results.

4. Encourage partnerships among business/labor, education, and government.

In many states, this tripartite collaboration is already taking place. Business has a stake in education, and its active participation in improving education is heartening evidence of a new era. Partnerships hold great promise and should be encouraged.

5. Support both good programs already in operation and new programs aimed at reform.

Much of what goes on in American education in schools and colleges is good and needs strengthening, yet reform is needed as well. Encouraging innovation and disseminating the results of evaluation is a special federal responsibility. The use of computers as a tool for instruction is an example of an exciting innovation with enormous potential that needs to be developed.

6. Emphasize talent development among minorities and women.

A smaller group of young people will be required to carry a heavier work burden in a more complex, technological society in the years ahead. Within ten years there will be 20 percent fewer college-age students entering the work force. And by the year 2000 upward of 30 percent of these young people will be black or Hispanic, the very groups now at the bottom of the educational and economic ladder. The nation will need all the black, Hispanic and female doctors, engineers, and scientists that we can educate. We can't afford educational casualties between now and the year 2000.

7. Enlist the best scientific minds of the nation to work on school and college curriculum projects as well as teacher training.

There is evidence, for example, that major revision is necessary in the school mathematics curriculum to adjust to the advent of calculators and computers. Old topics may not be necessary; new ones become possible and desirable. The top scientific minds from industry, universities, and schools should be brought to bear on these issues on a sustained basis. Much was accomplished after Sputnik. Major new efforts are now necessary, especially to build lasting bridges between schools and colleges for mutual benefit.

8. Recognize the dignity and worth of school and college teachers.

Top-down reform on a large scale will not work. For change to take place, teachers must be involved at the beginning and feel committed to change. Improvement of the status of teachers is a long-term objective that is absolutely essential to the nation's future as is the development of enhanced opportunities for teachers to refurbish their skills and knowledge.

9. Provide incentives to leverage and encourage state, local, and private investment in education.

A national approach to reform and support implies partnerships and multiple funding sources: federal, state, local, and private. An important federal role is to provide incentives for such widespread support and to build upon it. Matching funds, tax incentives, and loan programs are examples of appropriate mechanisms. On the other hand, targeted federal funds may also be necessary to ensure that underserved areas and populations have their needs met in the absence of funds from other sources.

Leveraging money is clearly a means to keep the federal price tag down while increasing the national impact. In addition, federal departments and agencies should be encouraged to look at their present activities in order to maximize impact across federal programs. For example, new uses for vocational education money may be appropriate, and there may be Defense Department funds that could properly be used for mathematics, science, and engineering training outside the military to assure an adequate supply of trained manpower.

10. Build in a sustained federal role.

This is a long-term problem that will not be solved by a quick fix. Only through sustained efforts over a period of time will significant results occur. An initial three to five year program is only a beginning. First year funding should be modest to allow for adequate planning. Increased funding in subsequent years should follow. The precedents of the 120 year old Land Grant Act argue strongly for the merits of a long-term program to build and sustain our educational capacity and, through that capacity, our national economy.

We encourage Congressional leaders, the President, and others to help generate a nationwide dialogue on these issues. The current situation demands a sense of urgency and calls for bold and creative action. All major sectors are ready to pitch in behind leadership willing to put the highest priority on building our nation's human resources. Our economic vitality and national security depend on it.

In closing, I offer a few reflections in an effort to delineate the great challenges and opportunities that we face today.

One of the great hallmarks of American society has always been our openness to innovation, both technological and social. We encouraged generations of tinkerers of every sort, some of whom became great inventors. The westward movement, the filling up of a continent, the mastery of a frontier--all these provided a powerful impetus to individual ingenuity, group solidarity, and craft-based technological innovation. While these great traditions still flourish, a whole new development of massive proportions and immense significance has occurred. I refer to the emergence of large-scale science-based technological innovation. We have trained large numbers of scientists, provided billions of dollars per year for them to probe every conceivable mystery of nature, and built institutions of the highest quality in which they could freely pursue their inquiries. We have had strong advantages over other countries in this enterprise: extraordinary political freedom, openness to diversity and innovation on many fronts, and the broad scale of our commitment to excellence in higher education. This entire scientific enterprise has grown very rapidly during and since World War II. It has in recent decades generated fundamental principles, deep insights and powerful techniques--all of which lend themselves to technological innovation on a systematic and continuing basis going far beyond anything the world has known before.

The rapid acceleration of technological and social change in recent decades sharply heightens the importance of our educational institutions. Indeed, during the past year we are experiencing a sort of national rediscovery of education, particularly in reference to science and technology. This presents a challenge and opportunity comparable to the period when we as a nation boldly established the Land Grant Colleges at the time of the Civil War.

Among the basic issues we must address in the next few years are the following:

1) How we can give all our children, regardless of social background, a good opportunity to participate in the modern technical world, especially in preparation for modern employment opportunities?

2) What constitutes a decent minimum of literacy in science and technology that should be a part of everyone's educational heritage?

3) Given the rapidity of socio-technical change, how can we make lifelong learning a reality so that people can adjust their knowledge and skill to new circumstances?

4) Since educational institutions will more than ever be trying to hit a moving target as they prepare people for unpredictable circumstances, how can we help each other to prepare for change itself?

5) How can we enlarge the talent pool so that we can find promising people for science-based careers, regardless of their social background?

6) How can we broaden the spectrum of the sciences so that modern education will become increasingly informative with respect to the human experience?

7) How can the educational system foster a scientific attitude useful in problem solving throughout the society, in relating scientific principles to the major issues on which an informed citizenry must decide?

8) How can we achieve an informed world-wide perspective in an era of profound economic interdependence.

These are large and tough questions, but not questions that we can afford to avoid in the remainder of this century. The fundamental values of freedom, of opportunity, of diversity, of curiosity, of excellence, and of human decency still guide our institutions and always will. These enduring values, expressed through fine and diverse institutions all over the country, will make it possible for us to cope with the great problems of our time, to work steadily towards the humane uses of science and technology, and to take advantage of unprecedented opportunities that are emerging for the benefit of people everywhere.

Although the problems are formidable, no people anywhere ever had the opportunities we have now. We are in a critical period of transition. Short-term adjustments will not be sufficient. An obese person gets little if any benefit from a crash diet, but requires a permanent change in eating habits. So too, we require long-term improvements in education over a wide front if we are really to fulfill the promise of this nation in the 21st century.

(Note: In the interest of economy, certain supplemental material referred to in this statement was retained in the files of the Committee.)

Senator **Stafford**. Thank you very much, Dr. Hamburg.

The timing mechanism has broken down, and I didn't stop your very excellent presentation.

We will turn now to you, Mr. Salyer.

Mr. **Salyer**. Thank you, Mr. Chairman, Senator Pell. My name is Stephen Salyer, I am vice president and director of the education division of WNET Channel 13 in New York, the Nation's largest public television station.

Senator **Stafford**. Could you speak up just a little bit, Mr. Salyer.

Mr. **Salyer**. I am here representing WNET, the largest public television station in the country, and also the Association of Public Television Stations, representing all of our brethren throughout the country.

I am going to leave my written statement with you and with the time allotted to me, summarize just a few points that I thought I might highlight.

First, why we are concerned. I think Dr. Hamburg has given a very elegant statement of the problem and of the possibilities confronting us, so I won't repeat all of that. I would like to underscore, however, the point he began with and the point he ended with, and that is that the dimension of the problem and the concern that we are facing in the area of science, mathematics, foreign languages instruction is not one that will be solved in a day.

I am very pleased to note that your legislation calls for a 3-year time horizon for appropriations. We feel strongly that a multiyear approach is essential to being able to provide any significant leverage on these issues.

Senator **Stafford**. Excuse me. Would you pull the mike a little closer.

Mr. **Salyer**. Second, what do we bring to this area as public broadcasters? And as the only telecommunications system that operates in this country under public auspice; first, we bring national coverage; we are in 95 percent of the homes of the country. We bring such programs as "Nature," "Nova," "Life on Earth," "Cosmos," "Body in Question"—programs that are watched by literally millions of persons, and we believe have been a source of inspiration and of sound information which has led the American public increasingly to look to public television as the only consistent source of information on subjects of science and technology.

Third, and this is less well known because it lies a bit beneath the water's edge; we are, and take quite seriously, our role as educational broadcasters. Virtually every station in the country remains involved in and committed to formal instruction and education as well as to general audience programing.

We provide services to many, many of the school systems in this country on a daily basis. In New York alone, we reach some 600,000 students each week with our daytime instructional programing and provide on a for-fee basis services to some 16,000 teachers, directly out of 1 station.

Fourth, we are involved currently in major efforts to provide what Dr. Hamburg referred to as lifelong learning, which we think will be a terribly important part of our ability to cope with the issue before this committee in the future.

Persons are looking for convenient ways to find training, information, and courses of study to upgrade their skills and understanding. We think the broadcasting system that has already tapped some billion dollars of the Public Treasury to create is an excellent and cost-effective mechanism for providing some of what is required.

It is very clear that technology as a component in providing training and information is no substitute for teachers, and good teachers; teachers teach, machines don't. However, teachers need good tools, and we think that it is terribly important that in a field as complex as this, as rapidly changing as this, and as difficult to present as this, that we take full advantage of the media that are available to us to present difficult and complex concepts.

What we recommend, Mr. Chairman, is that your committee consider a twofold plan. One, support for reinvigorating the public understanding of science program within the National Science Foundation. A television series such as "Nova", "3-2-1-Contact," which in its first season was seen by 22 million children in this country, and a series on the human brain that we currently are producing in conjunction with Scientific America are only possible because of funds initially provided by the NSF's public understanding of science program.

The diminution of that program simultaneously with cutbacks in public television's appropriation mean that our ability to provide a comparable level of programing in the future is diminished unless there are funds available for that purpose.

Second, we do have resources in place that can be used to provide and fashion instructional tools for use in schools and for teacher training. One example is a course we will be offering nationally this coming fall that will be an introduction to computers, aimed at teachers, and providing them with skills that they would not otherwise have a chance to gain on a person-by-person basis. There are two million elementary and secondary teachers in this country; all of them need to know more about the microcomputer; we think we have a cost-efficient way to help them gain the understanding they need.

Finally, Mr. Chairman, we believe that the funds that are necessary to leverage this kind of instructional activity and attention should be provided in a way yes, that encourages localism but that also encourages collaboration across district school lines, and yes across State lines. Even in a State the size of New York, the cost of preparing high-quality materials, the sort that make best use of media and that increasingly allow the student and the teacher to "talk back" or interact with it, are frequently beyond present budgets.

If there are not provisions for funds to be aggregated across district lines and across State lines, and indeed encouragement of that form of aggregation, it is our concern that the material prepared will be of the least common denominator form, or will be of less high quality than are required to make plain and helpful complex ideas of science.

We think, in conclusion, that we have broadcast and production resources in place that can be very helpful in solving the scientific literacy problem that confronts this country. We urge that the committee think of effective use of media and of the public telecommunications system as it considers this important subject.

[The prepared statement of Mr. Salyer follows:]

Testimony
Stephen Salyer, Vice President and Director, Educational Division
WNET/THIRTEEN

on behalf of the
National Association of Public Television Stations

before the
Subcommittee on Education, Arts and Humanities
Committee on Labor and Human Resources
United States Senate

April 8, 1983

Mr. Chairman and Members of the Subcommittee, I appreciate the opportunity to describe the potential of educational television for fulfilling some of the critical objectives of the emergency science and mathematics legislative proposals pending before your Subcommittee. My name is Stephen Salyer and I am Vice President and Director of the Educational Division of public television station WNET/THIRTEEN in New York. I am testifying on behalf of WNET, the nation's largest single public television station, and for the other public television stations throughout the country who form the membership of the National Association of Public Television Stations (NAPTS).

We share your concern and are committed to helping solve the problems you are debating today. This country is in a critical state--one requiring a growing pool of skilled educators, as well as students, becoming interested in and excelling in science and mathematics. But, just the reverse is occurring. Unfortunately, science and math teachers increasingly are leaving the field for more lucrative positions with industry. There has been a dramatic decline in the number of new science and math teachers trained annually by our colleges and universities. Both student enrollment in high school science and math courses and student achievement levels in these fields are declining. Only half of our high schools are able to offer science and math courses beyond the tenth grade. And, according to the 1982 report of the National Science Teachers Association, only half of the newly hired science and math teachers are qualified to teach these subjects.

We are attempting to answer these concerns.

In public television, over 90% of our stations today provide instructional programming for elementary and secondary classrooms or credit courses for colleges and universities. Over 15 million school children are regular users of the instructional television programming; the yearly cost per pupil is substantially less than the price of a single textbook. Over 55,000 students at more than 550 colleges and universities enrolled in the first year of the PBS Adult Learning Service. Those institutions of higher education participating in the adult program receive full tuition payments from students but their cost of providing the courses is quite low, in the range of $20 to $40 per enrollee. These courses have proved popular with students due to the quality and convenience of offerings made through stations and cooperating institutions of higher learning. This pattern of local station-college collaboration has now proven its cost-effectiveness in providing undergraduate, graduate and in-service courses. For example, 65% of the engineering graduate degrees in South Carolina are conferred to telecourse students and about 5,000 have benefited from Kentucky's inservice Master's Degree telecourse program.

Central to the effective design and acceptance of these courses is the experience of public television, on a limited budget, in producing programs in collaboration with master teachers. These programs are increasingly successful in combining sound instructional design with program formats that capture and sustain the interest of students. They also enable the presentation of concepts and dynamic processes difficult to illustrate on a blackboard or in a two-dimensional textbook diagram. Using animation, television can show a synapse firing in the brain, or can present an experiment beyond the reach of students in any but the most sophisticated laboratory settings. In such ways, scientific process and method can be revealed in an accurate and stimulating manner, encouraging further engagement and investigation.

Such visual presentations can prove particularly useful when connected with classroom activities available to students following viewing. Accordingly, a number of our stations are experimenting with ways to integrate television viewing and use of computer software into more traditional patterns of instruction.

New video technologies also show promise as educational tools.

Two of our stations are experimenting with the educational uses of teletext. Teachers involved in the experiments report that the interactive aspect of the keyboard/television screen material has a strong motivational effect on their students, particularly when used intensively. They have witnessed dramatic turn-arounds in the attitudes and achievements of kids who previously had little interest in learning or had not responded to traditional teaching methods. Two other stations are pilot testing interactive cable and videodisc technologies for college level courses. One of these courses is "The Physics of Structure," a college physics course which features individually-tailored instruction.

Although existing programs have been well received and widely used, and the experiments with use of new technologies encouraging, the ability to pursue these efforts on a major scale has been extremely limited. Of the over 150 series distributed by the Agency for Instructional Television (AIT), for example, only 18 are science oriented and only six concern math skills. Moreover, most of this programming is limited to once a week series of 15 or 20 minutes each and targeted at the elementary level. Only a few courses have been designed for learners at the junior high level and there are virtually no courses to meet the needs of high school math and science teachers and their students.

High quality, educationally-sound computer software is extremely scarce, and the cost of developing materials that combine the best attributes of video, print, and computer software is well beyond the reach of even the largest school districts.

This situation is as unfortunate as it is unnecessary. The program production and distribution capabilities of this nation's educational television system offer a unique resource for the improvement of elementary and secondary science and mathematics education on a wide scale and in a cost-effective manner. Because our system reaches about 95% of the U.S. population, it is especially well-suited to reaching vast numbers of people as well as targeting specific pockets of students. The system can, and does, provide college-level coursework to people without easy access to campuses, due to employment schedules, domestic demands or both. We propose that you use this system to create new learning tools for students, teachers and administrators of our nation's educational system as well as new and innovative learning tools for the American public-at-large in the form of original, regularly-scheduled science programming.

First, we propose, at the national level, a $15 million matching grant program be established for the effective use of instructional television materials. This matching fund could be used to foster state and/or local investments in the production of math and science television programming and related learning tools. This limited amount of targetted funding is essential to our ability to provide new services at a time when federal support for existing services has been reduced by $60 million.

Experts in these fields should identify the subject options and priorities for addressing them, just as they have done for the science and math instructional programs our stations have produced in the past. The possibilities include both specific and general courses: high-level college preparatory material such as calculus, trigonometry, statistics, matrices, physics, organic and inorganic chemistry as well as general courses necessary to enhance scientific, math and technological literacy among a large segment of our non-scientist population.

Each telecourse could be designed to meet multiple requirements: 1) in-service instruction (college credit) for emergency qualified science and math teachers; 2) material readily adaptable to the instructional needs of the teacher once he or she returns to the classroom, including video, computer, and print-based materials; and 3) in-service segments for qualified teachers to update skills and knowledge. Special segments for guidance counselors could prepare them to encourage their students toward math and science courses rather than seemingly less challenging subjects which appear to promise a higher grade. All of these materials could be adapted for a variety of distribution systems--broadcast, ITFS, cable, videodisc and computer-assisted instruction--to ensure widest possible availability and use.

Preference for the federal matching grants should be given to producers of instructional television programming with a proven track record--those who have demonstrated their ability to produce high quality material that educators have used and evaluated favorably at the K-12 and/or post secondary level. Preference also should be given to proposals involving collaboration across state lines. These, by definition, guarantee interstate distribution and use, and would encourage state and local educational authorities to consider proposals that respond both to local needs as well as to the needs of similar states. Multi-state proposals also reassure educational authorities that investments being made beyond their borders are helping them meet their local science and math needs.

It is important to note that the existence of such a matching grant program (for example two federal dollars for every state and/or local dollar), would not limit state or local use of the funds, but would encourage governmental and educational leaders to work with proven producers to provide material of highest quality and proven applicability.

Second, we need to revitalize the Public Understanding of Science Programs at the National Science Foundation. The value of public television programming is, of course, not limited to instructional material for classroom use alone. Programs such as The Ascent of Man, Cosmos, NOVA, Nature, Life on Earth, and The Body in Question have made our public television system the pre-eminent source of quality science information, and the only regular source of such information for all on a nationwide scale. And 3-2-1 Contact is the only science series for our young people, 23 million of whom watched it during its first broadcast run alone. Without the Public Understanding of Science Program at NSF, none of the science programs that have become household names might ever have appeared. There would be no NOVA nor a 3-2-1 Contact. And we at WNET would not be in the final stages of production on The Brain, a new series of eight programs produced in consortium with Japanese and French television, that span the range of worldwide research on the structure and functions of the brain.

The elimination of funds for the Public Understanding of Science Program has seriously eroded public television's ability to produce more of this programming. Despite the overwhelming success of 3-2-1 Contact, the Children's Television Workshop could not find a single corporate underwriter for an additional series; our stations will repeat the original 13-week series for the seventh time next year. What our young people really need is a full 36-week series, which teachers could use throughout the school year. With a reinvigorated Public Understanding of Science Program, this $5.5 million proposal could go forward.

In addition, NOVA is the only weekly prime-time science-oriented series on television today. But there is no weekly science magazine to keep the general population up-to-date on scientific and technological developments as Wall Street Week does for stock market trends. Only two short local series--Tomorrow/Today and our own local Innovation--have been produced. Instead, public television should be providing a full 52-week series (26 original programs and 26 repeats) with nationwide applicability and a permanent place on the PBS schedule for all interested Americans. Such a program would carry a price tag of about $2 million a year. And, like NOVA, it is unlikely to happen at all without a strong commitment, over a number of years, from the NSF.

Finally, it would be helpful for our stations and independent producers to be able to seek funding for topical science specials, such as "Spaces," a short new series which encourages young people, especially minorities, to consider a career in science and the proposed two-hour program entitled "A Quarter Century in Space," designed to examine the U.S. commitment to space on the 25th Anniversary of NASA. With a $10 million media set-aside for the Public Understanding of Science Program we could meet these three objectives--a daily program for our young people throughout the school year, a weekly program to encourage scientific literacy at all ages and an occasional science special.

Here, too, some limitations should be established to ensure the widest possible use of such programming. Preference should be given to proposals which are designed for instructional use as well as home viewing and which include ancillary material and unlimited broadcast and audio-visual rights for use in schools and other educational institutions such as libraries and museums.

Recommendations

Thus, we would recommend that the Subcommittee establish a $15 million federal matching grant program, where stations would have to raise dollars from private, state, or local sources, funding innovative educational training programs for teachers, students and school administrators in Math and Science.

In addition, a $10 million media set-aside in the NSF's "Public Understanding of Science Program" is essential to provide a daily science program for young people, a weekly magazine series to promote science literacy and prime-time science-oriented specials.

With these two steps, the Subcommittee would be making a major effort in combatting the illiteracy of the 80's--in science math, and technology--toward preparing our young people for a future filled with productivity and technological advancement.

Senator **Stafford**. Thank you very much, sir.

Dr. Nichols, we will be happy to hear you.

Dr. **Nichols**. Thank you, Senator Stafford, Senator Pell.

My name is Roger Nichols, and I am here as the Boston Museum of Science Director and Professor of International Health at Harvard University. I am representing the American Association of Museums and the Association of Science Technology Centers, and we are grateful for the opportunity to participate in these hearings being held on the Education for Economic Security Act.

We feel the legislation will begin to address the decline in math and science education at the precollege level. The AAM and the ASTC are national service organizations with a combined membership, 1,700 institutions. We represent science museums, national history museums, aquariums, science centers, planetariums, nature centers, zoos, botanical gardens, and those museums such as children's museums with a strong commitment to science and math education.

As such, we definitely support the first panel of teachers who represented the public school system. A strong element, of course, an indispensable element. And we certainly support the WNET and the public television and public radio system. But we would also like to suggest that museums are an element in the education picture. If you will, they have been described as powerhouses of education, and we can and should use them in attempting to arrest this decline.

Let me be specific, and something fortuitous came to my hand as I was traveling down here, I had the current Scientific American with me and the last article in the Scientific American is one on intuitive physics, written by someone in Johns Hopkins.

He finds that 49 percent of college students that he tested in this country believe that if a person is walking along holding a ball in his hand and drops the ball as he is walking, that the ball will fall straight to the ground. Another 6 percent believe that it will actually move backward; meaning that a majority of people, if college students in this country simply do not understand enough physics to realize that the ball will have imparted to it the forward motion of the person who is carrying it, and that it will fall to the ground in some parabaloid type of effect.

Senator **Pell**. I think if you asked that of 100 Senators——

[Laughter.]

Dr. **Nichols**. Senator, I will make a point not to ask that of 100 Senators.

Senator **Stafford**. Notwithstanding what Claiborne said, we do try to have a forward look down here.

Dr. **Nichols**. I'm sure.

The interesting thing about this study, which has been confirmed at the University of Massachusetts and at the University of Pittsburgh, as well as confirmed in a slightly different way at the Sorbonne in Paris, is that attempting to teach Newtonian physics to these students in a classroom does not disabuse them of this misapprehension. And that after teaching them Newtonian physics, 80 percent of them still have, or make the same mistake.

Now this is where science museums, if I may depart from the text—this is where science museums come in. What we are doing in these institutions are rolling balls off the edge of tables and dropping them simultaneously to see what happened, we are rolling things down inclined planes of various sizes; we are dropping feathers in vacuum and not in vacuum. In short, we are demonstrating. And we are demonstrating natural phenomenon in a way that is—am I already at 4 minutes? Goodness.

What we have then, are institutions that are involved in moving out to demonstrate, invite participation, they are in school systems; they are in shopping malls; they run van programs throughout the States. They train teachers both inside their walls and outside in outreach programs. They develop and test curricular materials. They develop textbooks. They run summer camps, computer courses, nature hikes, coastal cruises. I could go on.

But if our school system is not to be as frequently said, astronomy without the stars, geology without the rocks, and we might say botany without the flowers, we have got to have something like museums, arboretums, zoos, around. And I suggest that an important element of our complex educational system is that of museum systems.

Now before the Second World War, or even before the First World War, really; we didn't look upon the school systems as the sole source of education in this country. More and more, since the First World War and increasingly after the Second World War, if I get a stack of resumes on my desk, and the person stopped at the 10th grade, I am not likely to think that he is a well-educated individual. But that was not true until recently.

Lincoln would not think so; Edison wouldn't think so; neither would Eastman. And we must be sure that our education system is broad enough to take into account things like the public television and others.

Now I left an endowed professorship at Harvard with the firm conviction that museums are extremely important in this educational mix. I would like to state just one point since the red light is on. That I hope that you will allow, that you will take section 8 of the bill and allow museums to develop cooperative programs and teacher training, retraining and inservice training in conjunction with institutes of higher education and allow us to have funds distributed directly to us as well as to institutes of higher education.

We are already training teachers; we have been doing it for years, and I believe that this is an important component. The rest is in my written testimony, and thank you, sirs.

[The prepared statement of Dr. Nichols follows:]

STATEMENT OF ROGER NICHOLS, DIRECTOR, MUSEUM OF SCIENCE, BOSTON

Mr. Chairman and Members of the committee:

The American Association of Museums and the Association of Science-Technology Centers are grateful for the opportunity to participate in the hearings being held on the Education for Economic Security Act. We feel the legislation will begin to address the decline of math and science education at the precollege level. The AAM and ASTC are national service organizations with a combined institutional membership of 1700. We represent natural history museums, aquariums, science centers, planetariums, nature centers, zoos, botanical gardens and those museums, such as children's museums, with a strong commitment to science and math education.

Science museums share the concerns expressed by many of the witnesses that have appeared before the committee: too little math and science are available to school children; teachers are too few and often unqualified to teach these subjects; and the resources, in terms of curricula and equipment, are meager, out of date, and often out of touch with the ways in which children learn. Our experience with school children and families demonstrates that the natural curiosity of chidren to know how the world works, how to name and number things, makes them natural scientists and mathematicians. It is tragic that so much of this early enthusiasm and interest is lost because as a nation we have failed to provide to all children the opportunities to explore and study these subjects in consistent and engaging ways. The legislation under consideration, and the other bills that attempt to address this problem, are strong indications of a national commitment to reach a solution.

We would like to describe briefly the ways in which science museums have sought to stimulate learning about science and math, and what contributions these institutions can make to solving the large and complex problem that faces us.

For those who have not spent much time in museums of late, they have changed enormously in the last ten to fifteen years. The changes are particularly noticeable in science museums. There are a number of reasons for this. The first is the enormous scientific and technological advances that occurred in the last two decades. Space exploration, new knowledge about the earth and its history, changes in energy production and need, the new insights of basic research into the nature of the atom, and the astounding growth of computer technology, all contribute to a revitalized science museum and an increasing public demand for information about events with profound implications for daily life and the development of public policy. This natural expansion has coincided with an increased reliance by local schools on museums for supplemental programs in science and math, for museum programs that complement the curricula, for teacher training and for the "hands-on" experience in computers and laboratory work that the schools, for economic reasons, are often unable to provide. The results of these pressures have been an increase in services and a level of success in math and science education that is uniformly high.

Museums have succeeded in promoting stimulating and effective education programs in math, science and computer principles because they can risk innovation and experimentation. They have highly trained staff to design and implement programs, and they enjoy widespread support within their communities. Museums have an unusual advantage when it comes to education. Children enjoy museums; museums are inviting and stimulating places for them to learn. To paraphrase Frank Oppenheimer, a leading museum director, no one ever flunked museums. The level of motivation with which museums are approached is the key to the quality of the learning that takes place in them, and in other informal education settings. Similar effects are achieved when museums move into the schools through traveling computer vans, suitcase exhibits, educational kits, visiting curators and museum scientists.

Increasingly, museums are offering opportunities to teachers to learn more about subjects in math and science and effective methods of teaching. There is also increasing collaboration between teachers, schools and museums in the area of computer use. The extensive use and availability of computers in science museums has resulted in a wealth of technical information about computer programs suitable for use at various grade levels, and the most efficient means of introducing and using computers in schools.

The kind and variety of programs that science museums provide are detailed in a paper submitted with this testimony that Bonnie Van Dorn, director of ASTC, presented to a national conference of educators organized by the National Institute of Education. In Section 7 of the legislation under consideration, museums are provided with opportunities to strengthen collaborative programs with schools and to obtain support for the development of exemplary programs and instructional materials in math, science and computer education. These are opportunities that museums welcome. The scale of a museum's programming is limited severely by the resources it can locate for these activities. There is currently no federal support for such activities in museums, and local and state support has also been limited. The funds available through Section 7 of the Education for Economic Security Act will enable museums to broaden their services to communities and schools, and to contribute to the solution of pressing national problems in elementary and secondary education.

In Section 8 of the bill, which deals with higher education programs, the training of teachers is addressed. Under this section, museums can develop cooperative programs in teacher training, retraining and in-service training in conjunction with institutions of higher education. The funds available in this section are distributed directly to institutions of higher education, including junior and community colleges, according to state developed criteria. We feel strongly that given the already significant contributions that museums make in the area of teacher training and in-service training that they be among the primary institutions eligible for these funds. This would enable them to take the initiative in developing cooperative programs with colleges and universities. We urge that Section B (c) (2) be amended to include museums and that they be defined in Section 3.

We also encourage the committee to give consideration to including in the bill funds for states to undertake assessments of the resources and programs available in the areas the bill addresses as an aid to local education agencies in the development of their own programs and in the acquisition of services. Such assessments would avoid duplication and false starts. The problems that the legislation addresses are too serious and too pressing for funds to be lost to a lack of reliable, state-wide information.

With the same end in view, we encourage the committee to consider authorizing the establishment of independent, regional centers. Such centers could undertake projects that are accomplished more efficiently and with greater economy on behalf of a number of states than by each state working alone. Projects might include the development and implementation of new curricula; the development of uniform standards for teacher training or certification; regional or national mechanisms for the exchange of information; and research into effective teaching techniques, learning environments and programs for special school populations.

The AAM and ASTC thank the chairman and members of the committee for the opportunity to testify.

SCIENCE MUSEUMS AND SCIENCE EDUCATION

by

Bonnie VanDorn, Executive Director
Association of Science-Technology Centers
1016 16th St., NW
Washington, DC 20036

February 10, 1983

This paper was presented at the Conference on Teacher Shortage in Science & Mathematics: Myths, Realities & Research. The conference, held on February 8-10, 1983, was sponsored by the Teaching and Instruction Division of the Teaching and Learning Program, a division of the National Institute of Education. The conference was intended to focus attention on the myths about the shortage of science and mathematics teachers in the nation's schools, to sharpen awareness of realities and research concerning science and mathematics education, and to explore diverse approaches in dealing with the problem.

Any portion of this paper which is quoted or reprinted should include proper credit to the author and the conference sponsor.

Science Museums and Science Education

Complementing the schools' efforts, science museums offer programs at the cutting edge of science education activities in the United States and the world. Mobile computer van programs, science camps, programs for handicapped youngsters, teacher inservice training and the use of participatory exhibits that actively involve the visitor are examples of areas in which science museums excel. This paper describes many such programs offered by the approximately 100 museums in the United States belonging to the Association of Science-Technology Centers. (A complete listing of the Association membership is included at the end.)

The variety of science museum programs is striking. Meant to address the needs of very diverse community audiences, museum programs are designed for many age groups, ability groups, interest levels, and educational levels from preschool through higher education. Types of programs are equally diverse ranging from the very informal exploration of exhibits to formal classroom situations where graduate credit may be offered.

A common characteristic of museum educational programs is the involvement of other educational agencies, private and public organizations, and the media. These collaborative efforts often have a long history preceding the current emphasis on encouraging partnerships among schools, government, and the private sector.

Encouraged by the public enthusiasm for science museums, many communities within the United States as well as other countries are planning or have recently established new science centers or a new educational emphasis for existing museums. These contemporary science museums are dedicated to improving the public understanding of science and technology. They provide a science education resource that is significant and not yet used to its full potential. Expansion of exemplary museum programs is possible through the creation of more incentives for schools and museums to work cooperatively, the establishment of ongoing funding support and the formation of a body of research concerning education in museum settings.

Although we generally think of schools when we talk of science education, a growing amount of learning about science and technology is happening in informal settings outside the classroom. Widely available computer technology has made teenagers unchallenged experts at video games and whizzes on home computers. There are dozens of popular science publications, spanning a wide range of sophistication - from Scientific American and Science '83 to Popular Science and OMNI. Although NOVA remains the only regular TV series dedicated to explaining science, other programs like "The Body Human," "National Geographic," "Life on Earth," "Cosmos," and "Discover" regularly attract viewing audiences of five to twenty million.[1]

Science museums also attract huge audiences. Representing only 16% of the museums in the nation, according to a 1974 National Endowment for the Arts Survey, they attract 38% of the museum-going audience.[2] A 1979 survey by the Institute of Museum Services reveals that science museums comprise 18% of the museums in the nation and attract 45% of the museum-going audience.[3] If zoos, planetariums, aquariums, arboretums, and nature centers are included, the total annual attendance is 150 million and equal to the combined annual attendance of professional baseball, football, and basketball![4] The National Air and Space Museum has an annual attendance of 10 million, approximately the same as Disney World and more than all the other museums of the Smithsonian combined![5]

In recognition of the popularity of these alternatives that make science fun as well as educational, the National Science Board Commission on Precollege Education in Mathematics, Science, and Technology states in its preliminary report that "...there is evidence that many students who have an interest in mathematics, science, and technology are not being reached through instructional approaches currently used in the classroom. Whereas many students do not like school science - and form this opinion by the end of third grade - many do like the science and technology they see on television. They also like what they encounter at science and technology museums, planetariums, nature centers, and national parks." The Commission advocates examining innovative instructional approaches used at such institutions and, where appropriate, applying them to the classroom.[6]

Many schools are capitalizing on the opportunity to "extend their walls" by working in concert with science museums. Traditionally, science museums' priority has been systematic collection activities and related research. Today their role increasingly emphasizes informal educational programs. Many contemporary science museums known as science centers have no collections at all in the traditional sense, but still value the use of objects to convey scientific knowledge and processes in a "hands-on" way.

The Association of Science-Technology Centers is a private nonprofit organization founded to represent science museums' common interests and to provide information and services to improve museum operation. Today the Association has 150 members, approximately 100 of which are science museums in the United States.[7] ASTC provides a communication network through its conferences, workshops, newsletters, and other publications; a traveling exhibition service which manages the tour of temporary exhibits to about 50 different museums per year; and training opportunities for museum professionals. The Association is funded by member dues, fees for services, special project grants, and corporate donations.

ASTC's members are very diverse, from the huge Chicago Museum of Science and Industry with its 14 acres of floor space to the tiny Museum of Health, Science, & Industry in Cincinnati, which has 2 staff members and is housed in the former women's lounge of the Union Terminal train station. Half the members have annual budgets under $1/2 million and half were founded in the last twenty years. All are nonprofit and provide extensive educational services to the public: exhibitions, films, planetarium shows, classes for all ages, trips & tours, lectures, and special events. According to a 1976 ASTC education program survey:[8]

o 93% of science centers work directly with the local schools to provide educational services

o 89% provide programs especially for teachers

o 75% have outreach services that bring programs into the schools o 33% cooperate with universities to offer training for degree programs (such as graduate level teacher inservice training)

The following are examples of the educational programs that science centers provide. They offer an update to the old stereotype of docents leading hordes of students on tours of halls past glass cases of musty exhibits. These programs are successful in their own communities and have potential for expansion or replication elsewhere.

Computer Programs

With the current hunger for computer literacy and the limited access to computer instruction in schools, science museums are experiencing a high demand for computer classes. Most science museums have followed the model of the Lawrence Hall of Science in Berkeley to offer literacy classes for all ages as well as opportunities for individuals to rent time on microcomputers. Whole school classes can register for lessons taught by museum staff in labs equipped with 15 or more computers.

A good example of the science museum community's response to this public demand is the Chicago Museum of Science and Industry's class program. Their spring 1983 program catalog features 36 different, five session computer classes for everyone 10 years and older.

Several years ago, the Oregon Museum of Science & Industry in Portland initiated a computer club for gifted high school students. Working with an advisor, the students produced programs of commercial value for the local community. The museum's more recent efforts emphasize younger children's introduction to computers through classes for grades 1-3, using the Turtle graphics of LOGO and PILOT.

Last summer Pacific Science Center in Seattle worked in cooperation with a local private school, which provided the facility, and several computer manufacturers, who supplied equipment, to offer a computer camp so popular that extra sessions had to be arranged. For a tuition fee of $175 students spent a week becoming familiar with computers and learning to use them as tools to analyze marine science data they collected at Puget Sound beaches.

In order to make their programs accessible to additional audiences, museums in San Francisco, Portland, and Seattle operate computer vans, and The Space Center at Alamagordo, New Mexico, plans to circulate one later this year. The Seattle computer van program has been selected for the National Science Teachers Association's top award this year in the "Innovations in Elementary and Secondary Science Teaching" category. The van brings 2 instructors, 15 Apple computers and a variety of day-long lesson plans to public and private schools. Funding is provided by user fees, foundation, and corporate grants. Portland supplements their van outreach program with a Rent-a-Computer-Person service for groups needing an instructor versed in BASIC and PILOT.

Several centers offer workshops for teachers and administrators to provide basic computer literacy as well as to acquaint them with ways they can use computers to teach science and mathematics. (Teachers need to learn how to select and evaluate software and courseware, how to manage classroom logistics when one microprocessor must serve many students, and how to use the computer to help with their own student assessment and clerical tasks.) Pacific Science Center has provided this service under contract to the Washington State Superintendent of Public Instruction and for university credit. Other museums may offer their teacher classes independently or in conjunction with local districts. Chicago furnishes a choice of five different brands of microcomputers for their training programs. This gives educators the opportunity to compare hardware and software in a non-sales atmosphere in order to make more informed decisions about district purchases.

Teacher Services

An increasing number of science centers have established links with local university colleges of education to offer teacher inservice training. A common course offering is "How to Use the Museum in Your Curriculum" or "Using Science Resources in the Community" as well as many other special science topics in environmental education, astronomy, biology, social science, and energy education. Frequently offered for graduate credit, these courses not only utilize the special resources of the museum and its staff, but also often motivate an interest in science among teachers who avoided science during their previous schooling.

Teachers can obtain a more intensive experience in residence at the Discovery Place in Charlotte, North Carolina, or on sabbatical leave at the Pacific Science Center or the Oregon Museum of Science and Industry. These elementary educators teach and learn at the science center not only to improve their own science teaching quality, but also to develop leadership skills to conduct inservice training for their colleagues when they return to their districts. This experience can earn credit toward a master's degree at several universities.

Museum educators recognize the important role that classroom teachers play in assuring that students make the most effective use of the museum. Teachers are encouraged to become acquainted with the museum through free admission incentives, educator open houses, introductory materials, and pre-visit workshops.

Equally as important as preparation for the museum visit is follow-up. The Franklin Institute Science Museum in Philadelphia has developed the Science Enrichment Service, which are kits that teachers can take home to continue investigation of a scientific topic their classes studied at the museum. Each kit contains a poster, activity sheets, and a detailed teachers guide for further exploration.[9] Other museums distribute children's publications, loan kits, and provide activity packets for additional follow-up.

Curriculum Development

The Lawrence Hall of Science, part of the University of California at Berkeley, is a national leader in the development of science curricula. Examples of their published curriculum projects available for school adoption include: Science Activities for the Visually Impaired (SAVI), Science Curriculum Improvement Studies (SCIS), Outdoor Biology Instructional Strategies (OBIS), Health Activities Project (HAP) and others. All are highly motivational, involving students in the science experimental processes. In addition to curricula, museum educators have developed computer software and courseware for classroom use especially at the junior high level.

Science Accessibility for Special Groups

Bringing science experiences to disadvantaged students, those with handicaps or women and minorities, is a priority of science museums. The Mathematics & Engineering Science Achievement (MESA) program at the Lawrence Hall of Science provides encouragement for minority students to pursue science careers. In a similar way, the workshops and curriculum materials of the Hall's EQUALS program give women students career guidance and incentive to elect mathematics classes in junior and senior high. These model programs have been emulated in other cities. Lawrence Hall also runs very successful Math for Girls classes in their weekend and summer enrichment program.

The Exploratorium in San Francisco offered workshops for parents, teachers, and administrators of disabled children. Workshop participants used the exhibits to experience the auditory, tactile, and vestibular perception problems often encountered by children with learning disabilities. This helped the participants better understand the problems faced by the children and taught them how to use Exploratorium exhibits effectively with them.[10]

Pacific Science Center developed a curriculum guide and kits for loan to teach marine science to visually impaired children. The activities are appropriate for use by all children in mainstreamed elementary classrooms.

Programs for Gifted

Many science museums offer special programs for gifted and talented youngsters. Two exemplary programs are conducted in Atlanta and Baltimore. The Fernbank Science Center in Atlanta (part of the DeKalb County School District) holds a block of intensive science courses for able high school students. Bused to the science center daily for the whole term, the students have access to the electron microscope, telescope, nature center, and other special equipment facilities and expert staff at Fernbank.

The Maryland Science Center in Baltimore employs over 100 parttime instructors, many who are Johns Hopkins professors, to provide science classes for academically gifted students who need enrichment and accelerated learning. Students are selected by IQ test scores, academic achievement, and recommendation to participate in these college level Student Science Seminars. The program is funded mainly by course fees.

Outreach Programs

Since science museums are often located in urban centers, many programs emphasize exporting the museum staff and resources to more distant communities. Besides computer vans, several museums have teams of teachers, small exhibits, and "hands-on" lessons that travel in vans to schools for day-long programs. Others, including the North Carolina Museum of Life & Science in Durham, provide classroom-sized inflatable planetariums and instructors to conduct astronomy lessons that teach youngsters to use starcharts and to do their own evening observation activities. Available for travel from the Portland museum are "Tooth or Consequences" - developed under the auspices of the Oregon Dental Association, "Clang, Bang, Toot - The Physics of Sound," "The Body Human," and other demonstrations to primary age children.

The Franklin Institute in Philadelphia is well known for its fine "Traveling Science Show" demonstrations on simple machines, chemistry, physics, and energy, which are conducted in schools by institute staff. With the support of a NSF grant, the Franklin Institute also established exhibits and demonstrations in a local shopping mall.[11] Their walk-through exhibit on mirrors and optics has been borrowed by the Science Museum of Virginia for display in the Richmond area shopping centers.

The Center of Science and Industry in Columbus, Ohio uses students to spread science activities to the schools. Funded by the General Electric Foundation, the Young Experimental Scientists Program brings groups of five elementary students and their teachers to the museum for a day of experiments and learning and then provides materials for the students to repeat the activities with their classmates at school.

A group of dedicated volunteers and a grant from a Pittsburgh area printing company makes possible a children's hospital program conducted by the Carnegie Museum of Natural History. Volunteers visit the hospital weekly, conducting activities about dinosaurs. The program helps to alleviate some of the children's fear about a strange environment and the trauma of a stay in the hospital.

The Ontario Science Centre in Toronto sponsors a Science Circus which travels to remote communities in the province for two-week stays. Their huge tractor trailer transports 3,000 sq. ft. of exhibits, a theater, and materials for workshops and demonstrations.

Special Programs & Events

Science museums are expert at devising creative programs to encourage learning about science and by necessity are also experienced at garnering the publicity, volunteer help, and financial support to sustain them.

Seattle's Banana 500 and Boston's egg race are contests which encourage participants to propel vehicles carrying the "cargo" by using a rubber band or a mousetrap. These contests are generously supported by the media and provide good community visibility for science and recognition for inventive achievement.

The Camp-In at the Center of Science and Industry in Columbus, Ohio provides an overnight camp experience at the museum for 35,000 youngsters and their scout or youth group leaders annually. Kids participate in science activities that they take home on topics such as cockroaches, crystals, and math puzzles.

The Oregon Museum of Science and Industry maintains several resident summer camps, of which the best known is Camp Hancock in central Oregon. There campers use local study sites to explore geology, paleontology, botany, ecology, and astronomy.

The American Association for the Advancement of Science and ASTC are working together to identify and place scientists in the community that are willing to volunteer at science museums. In Durham, North Carolina, this program has resulted in the science center coordinating the placement of "visiting scientists" into elementary classrooms. The scientists receive some guidance concerning the abilities and learning styles of the kids as well as suggestions for activities in their fields that would appeal to the youngsters. The teacher and students get to relate to "real" scientists dispelling some of the pervasive and erroneous stereotypes.

In Chicago and other cities, the local public TV station and the museum cooperated to offer teacher workshops on the topics covered in the following weeks "3-2-1 Contact" program. Exhibits and programs at the museum were also coordinated with the weekly themes. Museum staff developed student activity sheets to focus a museum visit on topics from the program series.

These museum programs and many others not mentioned hold great potential for helping to address our current science and mathematics education problems. The following are characteristics of science museums that make them deserving of the funding and research support necessary to meet this potential:

1. Museums provide unique exhibits, facilities, new technology, scientists, and educators not available in the schools.

2. The informal nature of the museum environment allows learning opportunities that complement the classroom. Frank Oppenheimer, director of the Exploratorium, explained, "No one ever flunks a museum... In contrast to classrooms, museums provide a reversible, deflectable, three-dimensional form of education." In his opinion museums are voluntary, entertaining, and necessary artificial environments for learning.[12]

3. The museum's general focus on public understanding and appreciation of science and technology seeks to create a level of science literacy and enthusiasm in the community in which school science program initiatives can flourish. For instance, families that attend science museums start their pre-schoolers early with activities to enhance their children's interest in science.

4. Science museums have a heritage of working with schools, businesses, community groups, and governmental agencies in the collaborative manner dictated by today's economy. They are experienced at attracting volunteer help and media support.

5. Major museum exhibit programs are cost effective. The National Science Foundation states that the costs and potential audience of successful science exhibits are directly comparable to the costs and impact of a public television program...usually pennies per person.[13]

Programs such as the Association of Science-Technology Centers' traveling exhibition service enable costly exhibits built by one museum to tour museums in several cities, increasing the potential audience by more than tenfold. The Exploratorium publishes an exhibit "cookbook" that many museums use to build their own exhibits inexpensively without costly development and design expenses.

In recent years the value of science museums as an adjunct to formal education and a catalyst for scientific and technological achievement has been recognized by leaders of many communities here and abroad. In the United States there are numerous small science centers being established, many by Junior League volunteers, parents, and educators. New science centers are starting in Canada, France, West Germany, China, Japan, Philippines, Malaysia, Indonesia, Australia, India, Saudi Arabia, Nigeria, Israel, and in other nations striving for technological improvement.[14] To accommodate this growing trend, ASTC recently created a new category of membership for developing museums not yet open to the public.

These fledgling science centers and the ones that currently exist will have a much greater impact on improving science education if several challenges are addressed:

1. Partnerships - More incentives are needed to get schools and museums working together enthusiastically and for mutual benefit. Establishing successful partnerships requires a substantial commitment of time and resources up front to identify the participants, communicate needs, inventory resources, set goals, and arrive at a firm commitment. This process does not happen magically and may take considerable effort and funding even before the actual cooperative project is undertaken. A first step is to improve communication between schools and museums through participation in each other's curriculum and educational advisory committees, at board meetings and through Parent-Teacher Associations, and other professional meetings. In addition to their Boards of Directors, some science museums have educational advisory committees to suggest the museum's program priorities in relation to the community needs. School administrators and teachers serve on these committees, assuring good school-museum cooperation. Likewise, museum personnel should support school district planning activities.

2. Funding - Most science museums struggle constantly for support, relying largely on earned income, business, and individual donations, and to a much lesser degree on federal grants and municipal support. With the exception of the modest funding from the Institute of Museum Services, funding from the National Science Foundation and other agencies has been for specific projects of limited duration. Support for developing innovative programs is vital, but it does not encourage sustained program efforts and may even exacerbate the museums' basic need for operational funds. How do we assure museums' basic support level so that museums can afford time to fundraise for new programs?

3. Research - The body of research that exists in other areas, such as education, can contribute to what is known about the effects of science education gained in the museum setting, but this must be done

very carefully and systematically. Research models developed for the school setting may not be suitable for science museum activities. The informal nature and novelty of the museum environment and the short duration of contact many visitors have with museums must be considered. More research is needed specifically about museum practices and about the long and short term effects of science museums both cognitively and affectively. Do museum field trips make a difference in classroom learning and behavior? Are there more gains for one type of learner or teacher than another? How effectively do exhibits communicate their messages? What kinds of program designs work best with family groups or very young children?

It would be a tragic waste not to overcome these hurdles so that the special resources of science museums can be fully tapped to help address this nation's complex science education crisis. Joel Bloom, director of the Franklin Institute reminded us at the National Academy of Sciences Convocation last May that "science museums present information...They excite people...Museums let people learn in their own way, at their own pace, at their own schedule."[15]

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Senator **Stafford**. Thank you, Dr. Nichols.

As we said, all written testimony will be carried in full in the hearing record. We will have a chance to examine it together with staff as we mark up on this legislation.

Let me ask a question of any member of the panel who cares to respond.

To what extent would a comprehensive Federal math and science education initiative result in first Federal goals determining State and local curriculum decisions and second, the possible neglect of other important subject areas.

Does anybody care to comment on that?

You all remind me a little of three other Senators and I who were up in the television gallery being examined recently, and each time a question was asked, we all looked at each other in the hope that somebody else would respond.

[Laughter.]

Dr. **Hamburg**. I would be happy to take a crack at it; I think that is something that has to be kept in mind. We do certainly cherish the tradition of reliance on State and local initiative in education, and I don't see any possibility that that is going to change. If you just look at it in dollar terms, the outlay for the public schools is over $100 billion a year in operating budget, so there is nothing on the horizon that the Federal Government could do or is at all likely to do that would drastically alter that.

I think that at every stage it is important to think about what is the distinctive Federal role, and I think one part of the role which Dr. Dranscomb emphasized in some testimony before a subcommittee of the budget committee recently, is to draw upon the great support of research which is clearly a national effort, a national R&D program that is unsurpassed, unmatched in history anywhere. We should draw from that and link this science base to the secondary schools. That clearly is something the Federal Government could stimulate, for example. I think every State and locality would welcome such an effort.

Senator **Stafford**. Thank you very much, Dr. Hamburg. We won't press anybody else to comment unless there is disagreement with what has been said.

Mr. Salyer, you suggest that a broad panel of experts should establish educational television programs-funding priorities, and that Federal assistance should be given to instructional television programers with a proven track record.

How should the Federal Government or State educational agencies address these concerns?

Mr. **Salyer**. I think the problem that we confront, as I indicated briefly in my statement, is one of using resources in place that are capable of bringing rapid and effective assistance to some of the areas that we need to address.

There are centers of production excellence within the public television system. These centers are found in many different parts of the country.

It is also true that public television stations work extremely close in most States with the State departments of education and with local school systems. In fact, a group of educational telecommunications specialists met last week in Washington; it was not strictly a public television meeting; it included representatives of State departments of education talking about ways in which we could collaborate across State lines to produce high quality science and math materials for use in schools.

I think there is the willingness there. I think what often happens, however, is that when moneys are available broadly in State capitals, unless there is some incentive or language that provides encouragement of a rather specific and strong sort, there is a tendency for it to be spread a bit across the waters.

So I guess I would only echo the comments of Dr. Nichols, that I think language that would encourage aggregation, collaboration, partnering between institutions that share concerns, that have complementary abilities and skills, is something that would be very desirable.

Senator **Stafford**. Thank you very much.

Dr. Hamburg, how willing are business enterprises to work with not only colleges and universities but also local schools to help develop more technologically literate populations?

Dr. **Hamburg**. I think the awareness in the business community is spreading very rapidly. It is at a higher level than I have ever seen it, and I was impressed when we put together our conference, you know on 3 or 4 weeks' notice, that we got a number of leaders in the business community to come and take a serious part.

You see a number of State and local initiatives that I think demonstrate the point like the so-called adopt-a-school program.

I don't think we have really tested the extent to which the corporate laboratories could join up with secondary schools in their regions. That is a particularly good area for encouragement in the years to come, but it does seem to me the time is ripe to test the limits of such partnership, and I feel optimistic about it.

Senator **Stafford**. Any disagreement from the panel?

Mr. **Salyer**. Mr. Chairman, I might just add to that, that we, too, have been in discussions with a number of the major corporate laboratories, including representatives from Xerox PARC, IBM, and Bell Laboratories.

And we feel there is a growing interest in a nonproprietary approach to developing ideas and concepts useful in developing learning materials. A number of the private firms as yet have not seen a marketplace sufficient to justify the investment in state-of-the-art learning materials; Federal interest and encouragement in this area could provide a carrot that would be very useful.

Senator **Stafford**. Thank you.

A final question. Dr. Hamburg, a recent Washington Post Op Ed piece suggested that the vast majority of new jobs in the 1980's and 1990's will not require extensive upgrading of technological skills, and that the greatest labor market needs will be in the area of relatively unskilled jobs.

Would you care to comment on that?

Dr. **Hamburg**. Well, I think that is a very fascinating problem area and that there are great differences of opinion about what will be needed. The likelihood is that there is going to be a pervasive mechanization of work, in the service sector of the economy as well as in the smokestack industries and in high tech.

The form the mechanization will take will differ a lot from one sector of the economy to another. The robots dramatize it, but in a way the robots are the tip of the iceberg; the applications of computers are of course the most pervasive aspect of it, with many different kinds of applications.

But I think the point is well taken, as we need to differentiate, you will need different kinds of skills by different tasks. It is my judgment, although I recognize it is a very complex area, that on average you will need a considerably higher level of technical competence in virtually every sector of the economy, but the form it will take will differ a lot, and we certainly are not going to solve all our problems by getting more engineers into high-tech industry, as important as that is. There is a lot more to the economy than that.

Senator **Stafford**. Thank you very much.

Senator Pell?

Senator **Pell**. Thank you, Mr. Chairman.

I think, Dr. Nichols, that your point that museums should be an element in the educational picture, one with which I agree, and one which this bill takes into account. You have before you a copy of the bill. The point you made that funds should be able to go to museums is already in the bill as I read it. Would that be correct?

Dr. **Nichols**. We may have been confused about the title of it under line 3, Higher Education Programs. We were uncertain whether these funds allocated to museums were to be used for higher education programs or in the training of individuals for primary and secondary school, if you follow me.

At the top of page 12, this entire section falls under higher education. And so we were confused as to whether funds would be available to museums for the instruction and training in primary and secondary schools.

Senator **Pell**. My understanding is that they are for both and there is also as you know a provision on page 9, middle of the page, line 15, where it refers again to museums. It says that such instruction programs may be carried out in agreement between public agencies, business concerns, and nonprofit organizations, including museums, libraries, and other appropriate institutions.

So what we have done here is to do our best to accommodate the museums.

Dr. **Nichols**. Excellent.

Senator **Pell**. If you feel this language should be changed, please be in touch with us, and we will take your thoughts very much into account, because we in this subcommittee do believe that museums play a very real role in instruction.

Dr. **Nichols**. Thank you.

Senator **Pell**. Now, the point that was raised by Mr. Salyer concerning the use of educational television, telecommunications in upgrading math and sciences instruction, this would seem to be an excellent thought; that is one that I am sure that some members of the subcommittee will want to weave into the final version of the legislation and one that we will take into account.

What you are seeing here is the process of a bill as it loses a great deal of its original specifics and acquires others, which one hopes both improves the bill and enhances its opportunities for passage.

One other question concerning museums that I will put to Dr. Nichols is in reference to the fact that museums already serve a pretty good size of the school-age population. Do you think that greater collaboration between museums and schools would mean an increase in the number of visits made each year or an increase in outreach activities that museums could develop for the use in schools itself?

Dr. NICHOLS. Both, Senator. In the museum which I direct, we have in the last few years begun a multiple-visit program which moves children away from the one visit, which is sort of an outing to the museum per year to multiple visits.

Some of the school systems around Boston are now bringing their children to the museum 12 times a year. And in that they settle down in a given exhibit, whether it is on energy or fluid hydraulics and actually learned the discipline at hand.

We are also involved in outreach programs with teacher training; we have been doing teacher training inside the walls of the museum and now we are moving outside to train in our catchment area which includes going up into central New Hampshire and Vermont and western Massachusetts and other areas as well in collaboration with institutions of higher education.

So that is very successful and we are happy about it.

Senator PELL. We had a program at one point in my State where every youngster went through a museum—the Rhode Island School of Design. Now, because of tightening of funds, that program no longer exists, but we hope that it can again be started.

Thank you very much.

Senator STAFFORD. Thank you, Senator Pell.

And for the subcommittee, may I express our appreciation to all three of you for giving the time and the attention to this matter which truly will help us very much in working out a bill that we think will be good for the country and something, as Senator Pell said, that we can pass the Senate.

So thank you very much indeed.

At this point I order printed all statements of those who could not attend and other pertinent material submitted for the record.

[The material referred to follows:]

MARGE ROUKEMA
5TH DISTRICT, NEW JERSEY

COMMITTEES:
BANKING, FINANCE AND
URBAN AFFAIRS

EDUCATION AND LABOR

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April 12, 1983

The Honorable Robert T. Stafford
Chairman
Subcommittee on Education, Arts, and Humanities
309D Senate Courts
Washington, D.C. 20510

Dear Mr. Chairman:

It is our understanding that your Subcommittee is now considering legislation to address the critical shortage of math and science skills among United States students.

As you know, the House has already passed a bill, H.R. 1310, which dilutes this effort by providing teaching scholarships for potential foreign language instructors at the elementary and secondary level. While the scholarship approach is effective in the math and science areas, it is, in our opinion, clearly inappropriate for foreign languages.

Unlike math and science, there is no shortage of foreign language instructors at the elementary and secondary level. Recent studies have demonstrated that teacher supply is adequate to meet the demand for teachers in the major foreign languages and, in fact, there is a slight surplus in some regions. According to the National Center for Education Statistics, layoffs of elementary and secondary foreign language teachers was second highest among all fields - second only to art teachers. As a percentage of all shortages among teachers, foreign language teachers constituted a low 1.1% compared to 8.3% for math teachers, 5.5% for physical sciences and 2.1% for general science.

We do recognize the need for instructors in some of the more highly specialized languages, such as Arabic, Japanese, and Russian. In addition, we recognize the importance of proficiency in these languages to our high technology needs. However, it must also be realized that it is totally impractical to train teachers to teach these subjects at the elementary and secondary level. If the elementary and secondary schools are having problems getting students to take the more traditional languages -- hence, the surplus of instructors -- it is most unlikely that they will find enough interested students to be able to employ instructors in the more specialized languages.

Clearly, our education system's failings in the area of foreign languages are not a result of teacher shortages, but instead are a result, among other things, of a decline in foreign language entry requirements for colleges and a belief on the part of students that they do not need foreign languages for employment opportunities.

Therefore, we believe that the math and science effort should not be diminished by including approaches to foreign language problems. However, if foreign languages are to be included, we believe the focus should be in the areas where there is need (curriculum development, instructional materials, etc.) and priority should be given to courses designed to provide reading comprehension of scientific and technical journals in critical foreign languages. The funds should not be spent for training elementary and secondary teachers for jobs that will not exist.

Sincerely,

Marge Roukema, M.C.

John N. Erlenborn
Ranking Republican Member
Committee on Education
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STATEMENT ON MATHEMATICS, SCIENCE, AND TECHNOLOGY EDUCATION

IN THE 98th CONGRESS

submitted by

THE NATIONAL CONGRESS OF PARENTS AND TEACHERS
(The National PTA)

TO

THE SUBCOMMITTEE ON EDUCATION, ARTS, AND THE HUMANITIES
OF
THE COMMITTEE ON LABOR AND HUMAN RESOURCES

UNITED STATES SENATE

April 8, 1983

Mr. Chairman and members of the Subcommittee, we wish to thank you for the opportunity to submit testimony on Mathematics, Science and Technology education legislation currently before the Senate. The National Congress of Parents and Teachers (The National PTA) is the nation's largest child and parent advocacy organization with over 5 million members in the United States, the District of Columbia and Europe.

The status of science, mathematics and technology education in U.S. public schools and the critical shortage of qualified teachers in those fields are of deep concern to the National PTA. Our history of support for qualified teachers is exemplified by a resolution on Quality Education adopted by the 1977 National PTA Convention:

> "Resolved, That the importance of qualified, effective teachers who enjoy teaching and care about the development of each child be recognized and that the preparation, hiring, and retention of such teachers be supported."

The fields of science and math have also been of special interest to us. For example, in 1977-78 we cooperated with the National Science Foundation (NSF) to disseminate information from the NSF comprehensive study on science education. This effort included preparation of a brochure entitled, "A Question for Parents: How Good is the Curriculum in Your School?", which presented sets of questions that parents could ask about the science and mathematics instruction in their schools. Questions posed in that brochure included:

- "Are there adequate in-service programs at the local and/or district level? At the state or national level? Are there opportunities for teachers to update their knowledge, through university courses and scientific publications? Are there in-service programs and publications from which teachers can learn new techniques for teaching science?
- Are there opportunities for teachers at different grade levels to communicate with each other in areas of mutual interest and to share information that can help build a strong science program?"

These are some of the same questions being asked today as parents around the country and Members of Congress examine ways to strengthen the mathematics, science and technology curriculum in our schools.

Furthermore, the results of a recent National PTA survey on federal legislative issues sent to 30,000 state and local PTA leaders across the country and in the European Congress of Parents, Teachers and Students concluded that math and science education is one of the priority concerns of our members. As a result, on February 19, 1983, the National PTA Board of Directors adopted a Position Statement entitled: "Emphasis on Science, Mathematics and Technical Education." The statement says in part:

> "The National PTA believes that the United States must, once again, place an increased emphasis on the teaching of science, mathematics and technical skills in order to prepare its citizens for high technology occupations in business and industry and for the nation's defense.
>
> There must be a federal commitment to assist state and local education agencies in upgrading programs in elementary and secondary science, mathematics and technical education; and, America must address the critical shortage of qualified science and mathematics teachers."

The National PTA believes that the federal government must initiate a comprehensive program to assist public elementary and secondary schools in meeting the challenges they are facing in delivering quality mathematics, science and technology education to the nation's students. To be successful such a program will necessitate a long-term federal commitment and a major infusion of federal dollars. The National PTA also believes that neither the bill passed by the House, H.R. 1310, nor the proposed legislation serving as the major vehicle for consideration in the Senate, S. 530, contain adequate federal funding to meet the task. We are cognizant, however, of the fiscal constraints under which the 98th Congress is attempting to address the critical needs in science, mathematics and technology education.

Therefore, the National PTA has joined 24 other major national organizations representing elementary, secondary and postsecondary education in urging the Congress to pass legislation this year that could provide a strong foundation upon which a long-term comprehensive measure can be designed and enacted in the 99th Congress. We believe that the scope of this year's legislation should be limited to authorizing activities which can, under the current budgetary constraints, result in some positive steps toward improving the status of science, mathematics and technology education in our schools and colleges.

We also concur that the legislation should focus on:

* Activities to improve education in mathematics, science and technology at the elementary as well as secondary levels;

- Programs to guarantee participation of under-represented populations in the fields of science, mathematics, and technology;
- State and local needs assessments, plans to meet those needs and progress reports;
- Teacher retraining, including in-service programs, summer institutes and workshops with stipends provided to enable teachers to attend;
- Assistance to college students who would become math and science teachers with guarantees that students receiving such assistance would teach elementary and secondary science and mathematics for at least one year for each year of aid;
- National education research and development in mathematics, science and technology to improve instruction and student achievement;
- National policy studies and evaluations of programs provided for under the legislation; and
- Programs to upgrade the nation's postsecondary education in mathematics, science and technology.

There are, however, issues of National PTA concern which are not presented in the overall education community statement and need further emphasis. We request that this Subcommittee consider the following recommendations as it drafts its math and science measure.

Federal resources should be targeted to where the needs are the greatest.

In determining a formula under which state and local education agencies would receive funding under the legislation, the National PTA believes that local education agencies which bear the primary responsibility for delivery of educational services to students should receive the largest proportion of the resources. Such a formula should be designed so as to target funds to school districts which serve large numbers of economically disadvantaged students. Perhaps, the Title I formula could be used as a basis for allocating federal funds to assure that resources flow to school districts most in need. In addition, local districts should be guaranteed a minimum amount of funding so that rural populations can be adequately served.

The National PTA commends the sponsors of S.530 for including a provision which allocates resources to the schools which have the responsibility for educating dependents of armed forces personnel who are defending our country abroad.

Provide programs for underserved and under-represented populations.

Math, science and technology education will be the economic cutting edge for many students who must compete in the future job market. Presently, educational opportunity for many is uneven across the country and limited by school district wealth, availability of equipment and materials and the number of competent teachers in the areas of science, math and technology.

A major policy of the National PTA as stated in our Legislative Program is: "Federal and state support of services for children should insure equalization of opportunities." We believe that a number of populations are presently underserved in the areas of science, mathematics and technology education and under-represented in science, mathematics and technical occupations.

Today, the Congress is faced with the challenge of broadening opportunities for these populations through its science and mathematics initiative. We urge the Senate to authorize programs for the economically disadvantaged, minorities, girls and women, the handicapped, children of migrant families and the limited-English proficient. The development of innovative programs, instructional methods and materials to encourage the interest of such students and to improve their achievement in these education areas should be supported by the legislation. Furthermore, state and local education agencies should be required to document the efforts they are making under the legislation to assure participation of these students.

Federal funds for education should be appropriated only for public schools that are publicly controlled and tax-supported.

The National PTA adamantly opposes the private school funding provisions in both S.530 and the House-passed bill, H.R.1310, which are identical to those in the ECIA Chapter 2. Under the current Chapter 2 private school provision, non-public schools are receiving federal dollars equal to their enrollment which, according to a study by the Educational Voucher Institute in Ann Arbor, Michigan, amounts to over $48 million, more than 10 percent of the total program. It is unconscionable that while the public schools in this nation are still reeling under the federal budget cuts of recent years, non-public schools are receiving an increasing amount of federal aid.

In addition to this diversion of federal resources to private schools, public money is being allocated to non-public schools through state resources. Some state PTAs around the country conducted studies on how much their states were spending on private school services. Here are some of the results for the 1981-82 year:

Minnesota spent $53 million for private school services in addition to a state tax deduction for private school students;

Ohio spent in excess of $50 million for private schools;

Pennsylvania allocated more than $60 million to non-public schools;

New York provided over $200 million to non-public schools; and

New Jersey spent more than $57 million for private school services.

At a time when Congress is finding it difficult to adequately fund the public school system, how can Members of this Congress justify allocating new math and science monies to non-public schools which will amount to nearly 11 percent of the very limited dollars authorized in this proposed legislation.

Federal resources allocated to address the problem of science and mathematics education should not be provided at the expense of other basic education programs.

We urge the Senate to include in its bill the language in H.R.1310 that prohibits funding of an elementary and secondary science and mathematics initiative unless Chapter 1 funding is equal to or exceeds that of the previous fiscal year.

Furthermore, the National PTA believes that new federally supported science and mathematics programs at all levels must be paid for by new money, not by funds diverted from other basic federal education programs such as programs for the handicapped, impact aid, and student financial aid.

In addition, the National PTA is concerned about the provision in S. 530 requiring a state match for the federal funds. Where will such state monies come from? Will states find themselves in a situation where they will be forced to divert resources from currently operating programs in order to move ahead in the areas of science, mathematics and technology education? We believe that the Congress must answer these questions before enacting legislation which includes a matching provision.

Maximize Parental involvement in new science, mathematics and technology education programs.

Everywhere there is evidence of the pressing need for a resurgence of popular support for public schools. This is not simply a question of restoring confidence for research shows that parent and community participation in education programs actually help children achieve. It also shows that where participation is absent, the programs are not effective. The kind of public support the schools need -- the kind that is committed to ensuring both excellence and opportunity related to the new math, science and computer technology thrust --can come only from real and continuous community involvement.

A large part of the legitimate and vital role the federal government has to play in education is to provide for parental and community involvement in educational policy. As we address the difficult problem of science, mathematics and technology education, it is essential that parents be involved in the process of planning, developing and evaluating these programs. The National PTA believes any legislation must require:

- The involvement of parents on state/local mathematics and science advisory committees;
- The involvement of parents related to any needs assessment activities conducted at the state and/or local levels;

- The involvement of parents and other community members in the establishment of mathematics, science and computer technology goal setting at both the state and local levels; and
- The involvement of parents in evaluating the success of mathematics, science and technology curricula.

The success of our commitment will rely on a broad-based effort at every level of education and at every level of government. We know from past experience that adequate resources must be accompanied by community ownership, and ownership comes by involving every segment of the community, including parents.

Mr. Chairman, the National PTA commends the Members of this Subcommittee for their efforts in designing legislation that will be the first step toward upgrading science, mathematics and technology education in U.S. schools and colleges. Many have compared today's educational crisis to that of the 1950's when the U.S. was challenged by the Russian's successful space venture to upgrade our nation's capacity in science and technology.

The National PTA believes that the manner in which this nation confronts today's educational challenges will have even greater consequences than have our efforts in the past. Today, we have an opportunity not only to produce specialists in greater numbers, but to provide all of our citizens with the critical academic skills necessary for a productive life. This effort will require more than new initiatives in science, mathematics and technology education. It will necessitate a national commitment to our children, their education and their well-being.

We would fail our children and our nation if we settle for a "quick fix" of the problems we are facing today. Only a long-term, comprehensive effort directed at overall school improvement and integrating new technologies, math and science with other vital educational areas can offer the hope of success.

The 98th Congress has an opportunity to determine a new educational policy for the nation and set a course for the future. This Congress can turn a crisis in math and science into a renewed commitment to educational excellence and expanded opportunities for all segments of our society.

The National PTA appreciates this opportunity to express our views on this critical matter.

Testimony submitted for the Record
From Joan Ganz Cooney, President
Children's Television Workshop
To Hearing on Science and Mathmatics Legislation
Subcommittee on Education, Arts and Humanities
Committee on Labor and Human Resources
United States Senate
April 7, 1983

Mr. Chairman and Members of the Committee:

I'm writing in support of your effort to provide an adequate level of funds for science education. It is vitally important for this country to undertake long term support of science, math and technology education for children. In particular, I would like to focus upon the role of broadcast television in helping address this issue and to tell you about CTW's experiences with 3-2-1 CONTACT, our television series on science and technology for elementary schoolers.

America is falling behind other countries in science and technology. America's economic leadership rests on science and technology. But the hard fact is that these fields are not very appealing to America's young people. These negative attitudes translate over time into pools of professional talent inadequate to a technological age, and no less important, a general population which is scientifically illiterate even though it will be called upon to make critical choices about the uses of science and technology — from nuclear power to genetic engineering.

The problems of not enough students electing to pursue higher education in science and math do not spring full-blown at the high school or college level.

They start at the elementary grades, where teachers are least prepared to teach science, and where states are least rigorous in setting standards for science curriculum and for certification of science teachers.

As President Reagan said in his State of the Union message, "If a child does not receive adequate math and science teaching by the age of 16, he or she has lost the chance to be a scientist or engineer."

Adding to this bleak picture is the plight of school budgets. Faced with tighter and tighter budgets, they are compelled to cut their education programs, and give an even lower priority to science — because it is not considered an educational "basic." Well science is basic to our lives — and getting more so every day.

Although the level of factual knowledge is a problem, even more basic is the attitudinal problem, the need to get kids "turned on" to science — the critical target age range for doing this is eight to twelve. This is the goal and the target audience of 3-2-1 CONTACT, a national effort in place that deals successfully with the problem for this age range.

Television is a pervasive and powerful educational medium and can and should play an important role in science education.

3-2-1 CONTACT combines impact in the home, the school, and in special assemblages of children, such as the Girl Scouts; it reaches children and their families inexpensively. In the premiere run alone, there were more than 23 million home viewers. As for school usage, more than 500,000 teachers' guides have been requested and distributed. Cooperative work with the Girl Scouts of America has opened up new merit badge programs that specifically use 3-2-1 CONTACT as source material. In Washington, D.C. alone, over 10,000 merit badges associated with 3-2-1 CONTACT have been awarded to Girl Scouts. Large audiences in homes and schools reduce costs per program exposure as well. With repeat broadcasts of the series, it is reasonable to estimate the cost of reaching one person one time with one program from Season I at a penny. Such is the cost effectiveness of the television medium, programmed creatively.

3-2-1 CONTACT is widely used in classrooms as well. We offer free teachers guides and teachers training workshops in how to incorporate educational television. Over a two-year period, 3-2-1 CONTACT outreach staff directly reached 60,000 elementary school teachers in over 450 training workshops. This kind of effort is a valuable extra tool for teachers to have available, and our efforts in this area should be continued and expanded.

With major funding from the National Science Foundation, the Department of Education, and the Corporation for Public Broadcasting, we are now in the production of a second season of 3-2-1 CONTACT programs. For two years after the completion of the first season, we unsuccessfully sought renewal of corporate funding for this second season. The reduced funding means that we could not do a complete series of 65 programs, but only 40.

This points to the fact that federal funds have to be the major source of educational efforts in this area. What our nations's children need are not one-shot approaches to problems that were years in the making, but sustained, stable funding for effective television programming. The popularity and effectiveness of 3-2-1 CONTACT has already been demonstrated and I believe that we should continue to build on this solid base by producing additional 3-2-1 CONTACT series.

A commitment of $35 million over the next six years would enable production of three 65-program series. New programs will provide a continuing presence in the home and school for children; retain an audience with new material (rather than constantly repeating our first 2 seasons); establish a wider-based audience; keep abreast of the latest scientific and technological issues; and report on new developments in the field.

Both in its own right for children and also for its later contribution to solutions at the high school and college levels, such funding would be an investment not only as a supplement to science education programs in the schools, but as a nationally known and available educational resource, also speaking directly to millions of children in their homes.

The federal government stands as the only funding source related directly to science and technology, and our own experience is that without a central source with specific and dedicated interest, it is difficult to get focused momentum going in any area. I applaud your efforts and concern in what I believe is a critically important field.

Peer

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April 6, 1983

Mathematics, Science and Technical Education: What are the Issues for Women and Minorities?

Experts are predicting critical shortages of scientific and technical workers during the coming decades. As the number of technology-related jobs has expanded the supply of students qualified to enter into high technology fields has declined.

Emerging legislation targets improving mathematics and science instruction and increasing the supply of qualified mathematics and science teachers as key to eliminating this shortage. However, much proposed legislation ignores the consistent underrepresentation of women and minorities in mathematics, science and technology-related careers and in educational programs leading to those careers.

Where the Jobs Will Be

- The Bureau of Labor Statistics projects 48,250 openings in the field of mathematics/computer sciences each year through 1990.
- The demand for electrical and computer engineers will exceed supply by almost 40,000 by 1985, according to the National Engineering Manpower Project of the Electronic Industries Association.
- The U.S. will experience a shortage of 577,000 computer operators, systems analysts and technicians by 1990, the Bureau of Labor Statistics predicts.

Women and Minorities in Mathematics, Science and Technical Educational Programs.

- In 1978, Blacks received six percent of the bachelor's degrees in computer science, Hispanics, 1.8 percent and American Indians 1.3 percent.

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- Only 20 percent of the students enrolled in technical vocational programs are women.
- A 1977 study of entering freshman at the University of Maryland showed that 63 percent of the white men in the class had 3.5 years of precalculus high school math compared to only 31 percent of white women, 27 percent of Black men and 19 percent of Black women.
- In 1981, women received nine percent of the bachelors degrees in engineering.
- A 1981 survey of 113 school districts in Michigan found that boys outnumbered girls two to one in computer math courses.

Barriers to Participation in Mathematics and Science

Females and minorities often avoid science and mathematics programs because their educational experience discourages them from pursuing these fields. In general:

- Women and minorities get less encouragement from teachers, parents, counselors and others to take mathematics and science courses.
- Women and minorities have fewer role models in these fields and are less likely to be aware of the career possibilities in science and technical fields.
- Minority students may become stuck in remedial courses, which may not allow them time for more advanced mathematics and science courses.
- Many minorities attend schools where the quality of mathematics teachers and course offerings are poor or minimally satisfactory.
- Females tend to have a less positive attitude toward math than boys and are still likely to perceive mathematics and science as male domains.

Recommendations for S. 530, "The Education For Economic Security Act".

Congress has the opportunity to play a major role in eliminating some of these barriers. However, S. 530 as it stands now simply supports the status quo and takes no steps toward encouraging the participation of women and minorities.

We therefore recommend the following changes in S. 530:

- General. All state and local programs receiving federal funds aimed at improving mathematics, science and technical education must build in efforts to increase the participation of traditionally underrepresented groups. For example:

  1. All teacher training must include instructional methods and materials aimed at removing barriers to achievement and increasing the participation of females, minorities and other traditionally underrepresented groups in mathematics, science and technology-related educational programs and careers.

  2. Curricula and instructional materials developed under this Act must be designed to appeal to boys and girls, minorities and non-minorities.

- Federal Level. There should be established at the federal level a $10 million program for developing, reviewing and disseminating model programs and curricula aimed at expanding the participation of women and minorities.

- State Level. The states should be required to spend 10 percent of their share of federal funds for model, exemplary, or statewide programs to expand the participation of women, minorities and underrepresented groups in mathematics, science and technical education programs and careers, and for competitive incentive grants to local school districts that want to make increasing the participation of underrepresented groups a priority.

Women and minority males comprise the bulk of future workers. Currently they make up 53 percent of the workforce. The National Center for Education Statistics estimates that between 1980 and 1990 the overall minority school age population will increase 4.9 percent, while the white will decline 9 percent. By 1990 the youth cohort will be 30 percent minority nationally.

The formula for dividing federal funds among states and local school districts should be weighted so that poorer school districts get a proportionately larger share of funds. The

Senate should adopt the formula contained in H.R. 1310, the "Emergency Mathematics and Science Educational Act."

Women and minority males comprise the bulk of future workers. Currently they make up 53 percent of the workforce. The National Center for Education Statistics estimates that between 1980 and 1990 the overall minority school age population will increase 4.9 percent, while the white will decline 9 percent. By 1990 the youth cohort will be 30 percent minority nationally.

Unless we tap this pool of workers, the skilled worker shortage will only get more serious. Opening the doors to math and science careers to women and minority males is not simply an issue of fairness and equity. It is absolutely vital to the future health of our national economy that our educational system better serves the needs of women and minorities in mathematics, science and technical educational programs.

Senator STAFFORD. The hearing is now adjourned.

[Whereupon, at 3:16 p.m., the subcommittee was adjourned.]

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